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CONTENTS:

	PAGE
The Hissing Arc	531
Intercommunication in Railway Trains	534
Paper Cables as used in Telephony (*illustrated*)	535
The Winding of Galvanometers	537
Electric Piping (*continued*)	538
The Post Office and Telephony (*concluded*)	539
Starting a New Steam Plant	541
Relation between the Heat Given Off Inside Voltaic Couples, &c.	541
Joel Electric Motor Carriage (*illustrated*)	543
The Induction Coil Spark Analysed (*illustrated*)	544
The Municipal Trading Menace	545
The Balancing of Armatures (*illustrated*)	546
Reviews	547
Correspondence:—	
The Absolute Block System of Signalling on Railways	548
Trade in the Soudan.—On Wireless (?) Telegraphy	548
High Voltage Circuits.—The Ambleside Tenders	549
Business Notices, &c.	549
The Development of Brighton Electricity Works (*illustrated*) (*concluded*)	553
Notes	559
City Notes	562
Traffic Receipts	564
Share List of Electrical Companies	565
Market Quotations	566
The Institution of Electrical Engineers:—The Hissing of the Electric Arc (*illustrated*) (*continued*)	567
Expenditure upon Municipal Electric Lighting Undertakings	568
Electric Traction and its Application to Suburban and Metropolitan Railways (*continued*)	571
The Physical Society	572
Dynamo and Engine Capacities.—The *Terrible's* Boilers	573
The Equivalent of a Horse-power	573
Electric Lighting in the City (*continued*)	574
New Patents	575
Electrical Patents of 1885 Expiring in April, 1899	576
Abstracts of Published Specifications	576

THE

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THE HISSING ARC.

THE reading of Mrs. Ayrton's paper at the Institution of Electrical Engineers on March 23rd was an event of considerable importance. It is not only that valuable scientific work has been done by a woman, nor that she has read her own paper and exhibited brilliant experiments to a highly technical audience, but the paper itself was of very great interest and novelty, and marks a decided step towards the solution of a long-standing difficult and important problem. It is some four years now since Mrs. Ayrton first began to publish the results of her experiments on the arc, and we have been continually tantalised ever since by promises that a complete and connected account of her work would shortly appear in book form.

The problem was from the first attacked in a philosophical and clear-headed manner. Direct appeal was made to experiments, and those of a very laborious kind, and the results were stated in terms of quantities whose meanings admit of no dispute, and involve no hypothesis; no attempt being made to invent properties of the arc, such as negative resistance or back electromotive force, in order to support forced analogies with metallic conduction. The results are all referred to three quantities—the current, the difference of potential between the carbons, and the linear dimensions of the arc space. Plotting the observations on a chart, Mrs. Ayrton was able to show, in the clearest possible way, the true action of the external resistance and its relation to the existence and stability of a silent arc. She was also able to propose a formula expressing the relation between the current, the potential difference, and the length of the arc, which represents very satisfactorily the results of her observations in a form less arbitrary than many such expressions. At the same time she explained away a curiously paradoxical result that seemed to follow from her diagrams, viz., the possibility of the existence of silent arcs with two entirely different currents with the same space between the carbons. She followed up the investigation on solid carbons with experiments on carbon with a soft core, and showed clearly the general effect of this construction on the behaviour of the arc.

So far as the silent arc goes, apart from the question of the physical changes taking place in the arc itself, Mrs. Ayrton seems for the present to have exhausted the subject in her papers of 1895 and 1896, and her paper read last month dealt with the difference between silent and hissing arcs. In one of her papers of 1896 she showed that the change of the arc from silence to hissing is always accompanied by a sudden decrease of about 9 or 10 volts in the potential difference, which is constant for all arcs between the same pair of carbons, and this phenomenon was repeatedly shown on the screen last week in the most brilliant manner. In that same paper a curve was drawn showing the relation between the current and the potential difference for all arcs between the same carbons when just on the point of hissing, and this

Mrs. Ayrton called the hissing curve. This curve showed that by gradually opening the arc the current that could be carried silently was steadily increased. Concealing the process under a cloud of analytical reasoning, she boldly extended this curve upwards, beyond the region of her experiments, to a vertical asymptote, and deduced a law which she emphasised with italics, that for any given pair of carbons there is a maximum limiting current which can be carried silently by an arc.

Now, the present paper deals solely with the arc when the current is greater than can be carried silently. Its most remarkable electrical property is that the potential difference between the carbons for a hissing arc is a linear function of the length of the arc and independent of the current ; and the strength of the current may have any value greater than that of the maximum silent current for that particular length of arc with the same potential difference between the carbons. Thus the current of the hissing arc may have any assigned value greater than the maximum silent current, and its magnitude is determined by the circumstances of the external resistance and the E.M.F. of the dynamo.

The hissing arc, then, is governed by a different set of laws from the silent arc, and the character of the phenomena appears to be quite distinct, and Mrs. Ayrton emphasised the distinction in the clearest possible way. Lastly, after having assigned the conditions which determine whether the arc shall be silent, at what point it changes, and what the current strengths, Mrs. Ayrton has been fortunate enough to discover the physical condition that determines the silence or hissing of the arc. The arc hisses if oxygen has access to the crater. In open arcs under ordinary conditions this only takes place if the crater reaches the side of the positive carbon, and so comes in contact with air, and the hissing is determined not only by the size of the rods and the current passing, but also by the form of the positive carbon near the arc. Thus if the carbon has burnt to a well-marked taper form a smaller current will bring the crater to the side and start hissing than if it has burnt to a blunt form. This explains why hissing begins with a smaller current in a short arc than in a long one, and also the existence of a maximum possible current for silent burning with a given size of carbon. When the crater is small and bathed in an atmosphere of carbon or carbonic acid no hissing occurs, nor can it occur with a closed arc or an arc in an atmosphere of nitrogen or carbonic acid. The behaviour of the arc in the presence of hydrogen is peculiar, and is to be the subject of a fresh series of experiments, which Mrs. Ayrton hopes will completely answer this and other questions connected with this very interesting subject. The difficulties seem to be yielding to Mrs. Ayrton's patient experiments and admirable method. Prof. Ayrton's stimulating personality and the ardour of his pupils at the Central Institution give her every encouragement and assistance. We look forward with the greatest possible interest to her next communication.

INTERCOMMUNICATION IN RAILWAY TRAINS.

The report of the committee appointed by the Board of Trade to consider this subject has now been some time before the public. As a report on a most important subject it would appear to be wanting in definiteness, since it leaves the subject in much the same position as before the committee was constituted.

It is, of course, no news to anyone who has considered the subject with any degree of care that the present cord system is deficient in many of the essential points of an efficient system. Something like 27 years ago Sir Henry Tyler reported to this effect. Neither are the conditions which an efficient system should fulfil in any way obscure. Interchange of stock makes it imperative that an uniform system should be adopted. Accessibility for use, reliable indication of the location of the user, and general reliability are all important features no doubt, but they are not now put forward for the first time. Considerations of first cost, and cost of maintenance are for railway companies only, and do not concern the public, except in so far as it can be shown that they are not excessive in comparison with their value to the public.

What then, it may be asked, is the cause of the delay in the adoption of a system which will be suitable and efficient ? Is not the answer to this question, "The excessive individuality of those to whom railway companies look for guidance in engineering matters." To anyone who is capable of looking at the subject from an impartial point of view, this seems the only possible answer.

Considering more particularly the electrical systems in use, do we not find that they are all based, essentially, on Preece's original system of balanced E.M.Fs., and that the differences are in mere matters of detail, such as the methods of making connections between carriages, the positions of the means of communication, the use of insulated or uninsulated returns, the advisability of taking advantage of other apparatus, &c., &c. ?

Some stress is laid in the report of the committee upon the advantages of combining the necessary electrical coupling with other couplings in use on the carriages, and the recommendation has, in part, given rise to a discussion now in progress in the *Railway Magazine* between Mr. Langdon and Mr. Hollins.

It may, however, very fairly be asked whether the point is of so much importance as seems to have been given to it ? Do railway companies now keep a special staff for the *coupling* of brake pipes, &c. ? Cannot the ordinary observer see this done at any important station by the nearest porter ? Do not the shunters do this work regularly ? What is the particular skill required to make such a connection as is requisite for the purpose under consideration ; or, why should it be assumed that it would be missed ? The *responsibility* for seeing that all parts of a train are in efficient condition does not rest with those who make such connections. Somewhat too much of a mystery seems to be made of electrical connections.

A point of much greater importance in the adoption of an uniform system of electrical intercommunication would, in practice, be found to arise in the maintenance of the immense number of batteries to be used under conditions far from favourable to the maintenance of such apparatus. Where passenger stock is interchanged to any extent the effectual supervision of the batteries would entail a large amount of detail arrangement, and the cost would be far from inconsiderable.

There are a number of other points which might be dealt with at length, but the only one that need be referred to here is the necessity that exists for any system to be *self-testing* before it can be considered entirely satisfactory. Such testing indications, moreover, should be of such a character as will prevent them from being confounded with the alarm signals.

As has been hinted already, the first point to be secured in order to obtain an efficient system, is to persuade individuals to sink their personal preferences, and to make less elaborate efforts to facilitate the work of future railway historians.

PAPER CABLES AS USED IN TELEPHONY, &c.

By E. J. J.

Paper cables have to a large extent revolutionised telephone engineering by making possible methods of working, which up to their invention had been more or less a dream of telephone engineers.

Anyone who has spoken over a long length of ordinary India-rubber or gutta-percha cable will have noticed the bad effects it has had on the clearness of speech, making it sound flat and dead; in fact, it sounds as if the currents had lost most of their energy. With a paper cable this is different; and it is almost, if not quite, impossible to tell whether you are speaking over an underground or aerial line.

The great difference in the speaking properties of rubber or paper cables is due to the much lower specific inductive capacity of the paper. That the capacity of a paper cable will be much lower than that of an India-rubber or gutta-percha one will be at once inferred from the fact that the specific inductive capacity of gutta-percha is 2·46; and India-rubber (pure), 2·34; while that of paper is very little above that of air, which is taken as unity.

The minimum capacity per mile of an ordinary India-rubber cable is 0·29 microfarad; while a mile of paper cable should not exceed 0·085 microfarad, and is frequently found to be lower; 0·080 microfarad per mile should be the average capacity of all the wires in any cable. The capacity tests are made with all the wires, with the exception of the one under test, earthed.

Paper cables are made up of various sizes, according to requirements, and are very compact, as will be seen from the following sizes:—

A	306	pair cable has an outside diameter of	$2\frac{3}{4}$	inches
A	250	" " "	$2\frac{5}{8}$	"
A	204	" " "	$2\frac{3}{8}$	"
A	153	" " "	$2\frac{1}{8}$	"
A	102	" " "	2	"
A	77	" " "	$1\frac{3}{4}$	"
A	52	" " "	$1\frac{1}{2}$	"
A	26	" " "	$1\frac{1}{8}$	"

The diameter of the larger sizes is kept small by the insulation being thinner and the wires more tightly packed.

The conductor of these cables is pure copper wire, No. 20 S.W.G. (36 mils in diameter) and has a resistance of 42·3 ohms per mile.

The insulation varies, according to the make of the cable, from 6 to 15 megohms per mile.*

The paper insulation is put on in a variety of ways, three of which must suffice for this article. The method most frequently adopted is to wrap a layer of tough paper $\frac{3}{8}$ of an inch wide loosely round the wire; this is then bound in position with thread. (See fig. 1, Nos. 1, 2, 3 and 4.) A second method is to lay the wire in a long strip of paper, make the edges meet, and over this fold another long strip, so that its edges meet on the opposite side of the wire to the edges of the first strip of paper. The whole is now wrapped round with thread to keep the paper in position. Two wires insulated as in these methods are twisted together to form a pair, the length of the twist being about 6 inches. The A and B wires of the pair are distinguished by the different colours of the thread used for binding the paper in position.

A third method, and one which gives the greatest amount of air space, is to twist a strip of paper, a quarter of an inch wide, into a spiral, similar to the spiral of an augur, but with a pitch of about 3 inches, lay a wire on each side of the spiral strip, then wrap the whole tightly round with a strip of tough paper, $1\frac{1}{2}$ inches wide. These two wires will form one pair. (See fig. 1, No. 5.)

The required number of pairs, formed by either of the above methods, are laid in layers round the centre pair with a slight twist, each layer being twisted in the opposite direction. The bundle of wires so formed is wrapped round with stiff paper, then braided with cotton threads, and finally enclosed in a lead sheath, forced round the cable by hydraulic pressure. After passing the necessary tests, the ends of the cable are carefully sealed to keep out moisture. It is now ready to be put under ground.

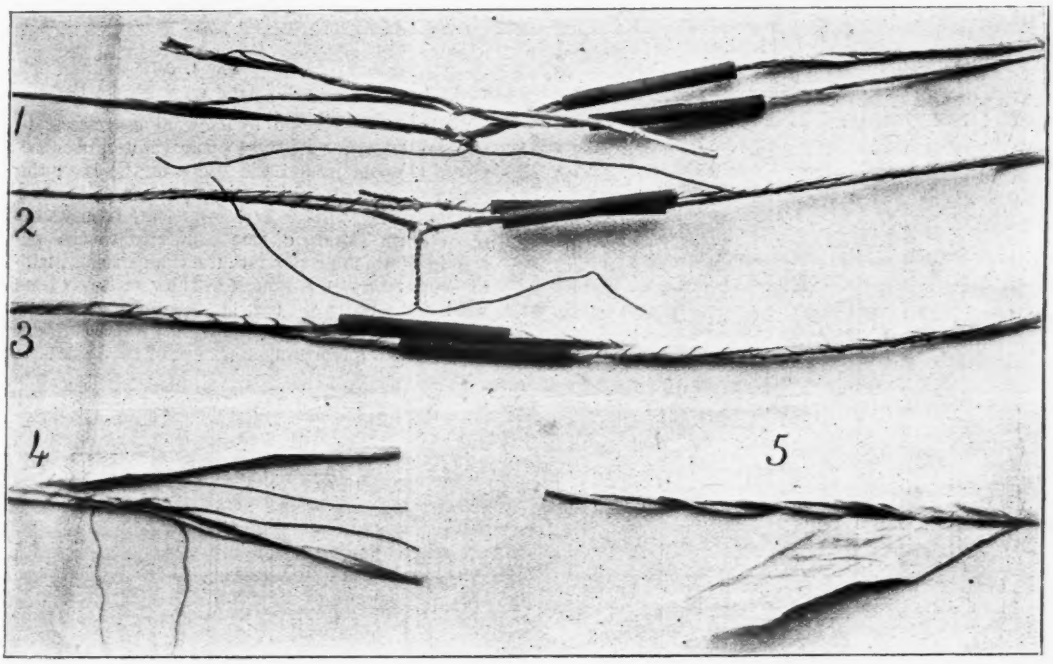

Fig. 1.

Paper cables are laid in iron pipes, lead jointed, or in cement conduits of such a size as to allow of sufficient space for drawing the cable in. The pipes are terminated with bell-shaped ends in brick chambers. The size of these chambers, or boxes, depends on the number of cables and on local conditions.

The cables are drawn through the iron pipes by means of a stout rope or a chain, fastened on to a cable clip; a swivel should be provided near the clip. The clip is fastened on to the end of the cable by means of stout iron screws. The end of the cable is frequently made up solid with lead for a distance of 6 inches, to enable this being done with greater security. (See fig. 2.) The

* Should not this be 6,000 to 15,000 megohms?—Eds. Elec. Rev.

other end of the rope is put round the drum of a windlass, which is placed over the cable box, and by means of a suitably arranged pulley in the box the rope is pulled clear through the end of the pipe. After the several lengths of a cable route have been drawn in the pipes, the next operation is jointing the various lengths together. Before jointing is commenced the cable box should be carefully cleaned out

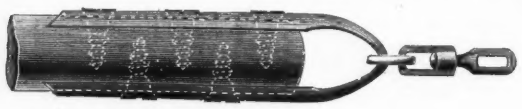

Fig. 2.

and made as dry as possible. When everything is ready, the ends of the cables are opened out for a suitable distance and the lead covering stripped off, the top layers of conductors are then turned back out of the way. It is desirable to joint the middle wires of each length of cable first, and then to do the others layer by layer. Before the joint is made, a paper sleeve is passed over each of the wires of one of the cable ends to be jointed. The ends of the wires are freed from insulating material for such a length that when put in the required position the covered parts of the wire will just meet. (See fig. 1, No. 1). The bare ends of the wire are tightly twisted together for a distance of $\frac{3}{4}$ of an inch, bent down (see fig. 1, No. 2), and the paper sleeve pushed

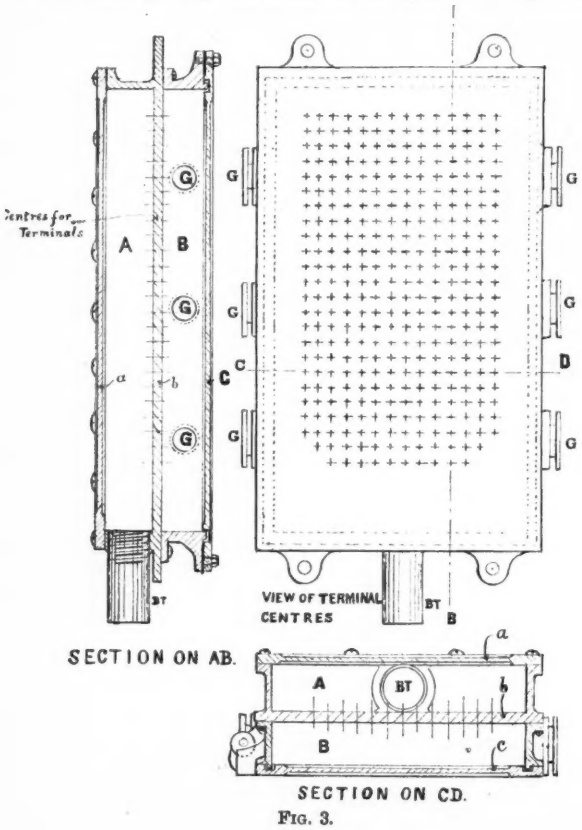

Fig. 3.

over (see fig. 1, No. 3). Care must be taken that proper twisted pairs are jointed on to corresponding pairs, for if one wire of a twisted pair be jointed on to an odd wire of another pair, overhearing will take place. After all the wires have been jointed and insulated by means of the paper sleeves, the joint is placed in a trough of heated lime to withdraw any moisture which may have been absorbed by the paper of the cable. When thoroughly dry the joint is closely wrapped with plain tape, a covering of sheet lead is now put over the joint and soldered on to the lead of the cable by a plumber's wipe joint; the junction of the edges of the sheet lead being also carefully soldered so that the whole is both air and water-tight. The plumbing must be carefully done, as any pin-holes or cracks will cause serious trouble.

The ends of the cable terminate in cable heads, which are iron boxes with a number of insulated terminals screwed through the back or sides according to pattern. Each terminal is insulated from the iron case by an ebonite bush. To the ends of the terminals, inside the cable heads, the cable wires are fastened, and to the ends, outside, the leads to aerial wires or instruments are connected.

The details of a cable head are shown in fig. 3. The lead covering of the cable is connected to the brass tube by means of a plumber's wipe joint, a sufficient length of the covered wires having previously been put through into the A compartment of the cable head.

Each pair of wires is now connected to a pair of terminals, commencing with the row nearest to the tube, B T. The distant end of this pair of wires is connected in a similar way to the corresponding pair of terminals in the cable head at that end of the cable. The cover, *a*, at the

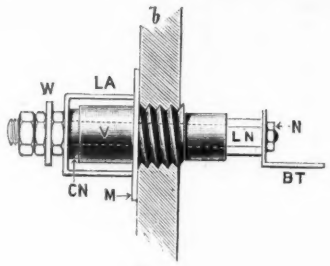

Fig. 4.

cable head is taken off to allow of easy access to the terminals; it is made air-tight by an India-rubber washer being placed between it and the edges of the box; the cover is fastened tightly in position by a number of screws.

The leading wires to aerial wires are brought through the screw down glands, G, and connected to the ends of the terminals which project into the compartment, B. The door of compartment B is hinged to allow of ready access to the wires and terminals. (See fig. 3, section on C D.)

The construction of the terminals will be understood from fig. 4, where *b* represents a portion of the back of the A com-

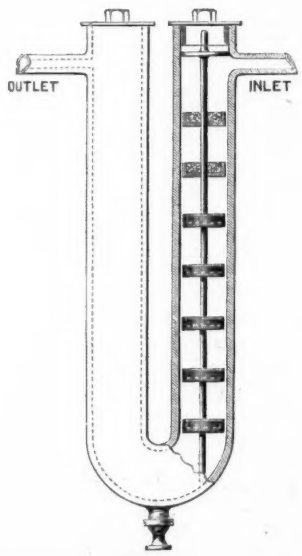

Fig. 5.

partment of the cable head. V is the insulating vulcanite support for the terminal, which is screwed into the iron back from the inside of the B compartment; it projects about half an inch on either side of the iron, so that the terminal shall be well insulated. Through this vulcanite bush is put a screwed rod of brass, about $2\frac{1}{2}$ inches long and $\frac{3}{16}$ of an inch in diameter; to one end of this is screwed the long brass nut, L N; on this is placed the brass connecting tag, B T, to which is soldered the wire from the cable. The whole is

held in position by the nut, N. The nuts are prevented from working loose, and a good connection is insured by the whole being sweated together with solder. The rod is now put through the vulcanite bush and held in position by means of the circular nut, C N. Over this circular nut is placed a strip of thin brass, L A, bent as shown, but prevented from making contact with the iron of the cable head by the thin mica disc, M. This forms the lightning arrester for the cable wire, the high tension currents due to lightning striking through this short high resistance path to the earth-connected cable head in preference to going through the cable and doing damage there. The thickness of the mica disc is exaggerated in the drawing to enable its being clearly shown. The outside wire is placed between the washer, W, and the nut which holds the lightning arrestor strip in position, a good firm contact being made by tightly screwing up the nut and lock-nut behind.

A cable head of this description may be placed in an exposed position, on a roof or up a pole, without any protection. When the cable terminates in a building the protecting cover to the outside of the terminals, compartment B, is dispensed with.

Paper cables work excellently, so long as the paper is perfectly dry. That this may be the case, during manufacture special pains and precautions are taken that the paper and small amount of cotton employed are perfectly free from moisture. The ends of the cable are also carefully sealed as soon as the manufacturing processes will allow. During the laying and jointing of the cable, the ends are never left open longer than is absolutely necessary; and, as before stated, the joint (after completion and before the lead covering is put over) is covered with heated lime, so that any moisture which may have been absorbed shall be withdrawn. Should, however, moisture from any cause get into the cable, it may be expelled by blowing dry air through it; the looseness with which the insulating material is packed allowing this to be done. To facilitate the blowing through operations, a brass nozzle with a screw cap is soldered into the lead covering of the cable at each end.

The air is dried by being passed through a series of U tubes containing calcium chloride. The U tubes are 4½ inches in diameter, and are made of metal. A number of circular trays (about eight) are fastened to a rod down the centre of each tube (see fig. 5). Rod and trays may be withdrawn to enable the chloride to be changed when necessary. The small tap at the lower part of the U tube is for allowing any moisture, which may have accumulated, being drawn off. From one to six U tubes should be employed, so that the air shall pass over a large surface of calcium chloride and be thoroughly dried. After being dried the air should be filtered by being passed through a copper cylinder, 1 foot in diameter and 4 feet high, filled with dry cotton wool. This will prevent any particles of solid matter, which would tend to clog up the air space in the cable, besides having other injurious effects, from entering the cable.

The air is forced through the drying apparatus and cables, at a pressure of 15 lbs. per square inch or thereabouts, by a Bailey or other suitable air pump. In Paris, air from the mains of the Compressed Air Company is used for drying purposes; after of course being dried and filtered. If the cable is known to be very wet at any particular place, careful warming of the cable will assist in the expulsion of the moisture.

The air escaping from the hole or crack by which moisture has entered, aids in the localisation of the fault, and shows by the hissing sound it makes, the exact place where the puncture or crack in the lead covering is.

As to the actual life of a lead covered paper cable, nothing can at present be stated, as none have yet been laid for a sufficient length of time to enable an estimate to be formed.

THE WINDING OF GALVANOMETERS.

Mr. Frank Laws in the *Physical Review* (America), Vol. v., has discussed the problem of winding galvanometers from a somewhat different point of view from that usually taken, and arrives at an interesting result. The problem is the following:—For a simple circuit consisting of a battery, a resistance, and a galvanometer, to determine the winding of the galvanometer so that its deflection will be a maximum. This problem has generally been discussed on the assumption that the thickness of the silk covering bears a constant proportion to the diameter of the bare wire. Mr. Laws points out that this assumption is quite erroneous, and gives instances of American silk covered wires. He says that in the case of a double silk covered wire, No. 20, B and S gauge, the diameter of the covered wire exceeds that of the bare wire by 12 per cent., and in the case of a No. 40 wire by 177 per cent. These figures are curious, as they make the double silk covering of the No. 20 wire 1·9 mils thick, and that of the much finer No. 40 wire 2·8 mils thick. For the finest English covered wires these figures would be 1·5 mils, and 1 mil respectively. The exact figures do not, however, affect the course of his argument.

Mr. Laws uses the following symbols:—

G is the galvanometer constant, *i.e.*, the field at the centre of the coil for unit current.

I is the current in the coils, so that I G determines the force on the moving needle.

b is the linear constant of the coil, whose volume $\propto b^3$.

r „ galvanometer resistance.

R „ resistance of the external circuit.

B „ diameter of the bare wire.

C „ diameter of the covered wire.

y „ ratio of C to B so that $C = B\,y$.

w „ resistance of the wire contained in a unit of volume of the coil.

n is the number of turns per unit of area of the section of the coil, so that n is inversely proportional to C^2, *i.e.*, to $y^2 B^2$.

E is the E.M.F. of the battery.

Now for coils of the same pattern and proportions, but of different sizes, G varies as the density of the current in the coil, and as the first power of the linear dimensions,

$$i.e.,\ G \propto n\,b \propto \frac{b}{y^2 B^2}.$$

Also the resistance of the wire in any given cubic space is proportional to the number of wires laid in it and to their resistance, *i.e.*, is inversely proportional to the square of the covered diameter, and to the square of the bare diameter. So $w B^2 C^2$, which equals $w\,y^2 B^4$, is constant.

Also the resistance of the galvanometer is proportional to the product of w by the volume of the coil, so that

$$r \propto w\,b^3.$$

From these equations is obtained

$$G \propto \frac{1}{y}\sqrt{\frac{r}{b}} \text{ and } \propto \frac{w^{\frac{1}{2}}}{y}\,r^{\frac{1}{2}}.$$

$I = \frac{E}{R + r}$, and I G is to be a maximum.

Now, in the problem most commonly given, the size of the galvanometer coils is fixed, and the thickness of the insulation is assumed to be proportional to the diameter, so that y and b are constants. Then $I\,G \propto \frac{\sqrt{r}}{R + r}$, and this is a maximum when $r = R$, *i.e.*, when the resistance of the galvanometer equals that of the external circuit.

Mr. Laws discusses the problem where the pattern of form of the coil is given but not its dimensions, so that b is a variable, and uses for this the second expression for G given above. The force, I G, on the galvanometer needle is now $\propto \frac{w^{\frac{1}{2}}}{y}\,\frac{r^{\frac{1}{2}}}{R + r}$. Now, whatever value may be assigned to r, the best size of wire will be that which gives a maximum value to $\frac{w^{\frac{1}{2}}}{y}$, an expression which depends only on the dimensions of the wire and its covering. By plotting the values of this expression for various sizes of silk covered wire, Mr. Laws finds that a wire of No. 34, B and S gauge, is the best size for all galvanometers to be wound to a given resistance, irrespective of the size of coils. Having ascertained this, the best value of r is such as makes $\frac{r^{\frac{1}{2}}}{R + r}$ a maximum, which gives $r = \frac{1}{2}$ R.

D

The best galvanometer of the particular pattern or family considered is one wound with No. 34 wire to a resistance of one-half of that of the rest of the circuit.

To show the practical effect of these conclusions, Mr. Laws takes two cases:—

If the coils of an ordinary reflecting galvanometer of 8 inches cubic capacity wound to 10 ohms resistance for working on a circuit of 10 ohms are replaced by smaller coils of the same form wound with wire of No. 34 gauge to a resistance of 5 ohms, it is said that the galvanometer deflection will be increased by 65 per cent., the volume of the coil reduced to one-fortieth of the previous amount, and the weight of wire reduced by a still greater amount. In a second case the coils of the same size wound to 1 ohm for use with a bridge are supposed to be replaced by very much smaller coils of ·5 ohm. The galvanometer deflection would be doubled by the change if double covered wire is used, and trebled if single covered wire.

It is interesting to consider the result of this argument applied to fine wires covered in England, where the difference between the diameters of bare and covered wires of higher gauge numbers may be taken to be constant, say about 1·2 mils. Calling this quantity d, so that $C = B + d$, the expression

$$\frac{n^2}{y} \propto B^4 (B + d)^{-2},$$

and is a minimum when $B = d$; so that for the conditions of Mr. Laws's problem all galvanometers should be wound with wire of 1·2 mils diameter, *i.e.*, No. 49 L.S.G., indicating the use of extremely minute instruments.

All these figures emphasise the force of Mr. Vernon Boys's plea for small instruments.

ELECTRIC PIPING.

(*Continued from page* 496.)

As regards the pendant or bracket fittings, these consist of similar standard china base provided with a small threaded nozzle, long enough to go through the cover and wood pattrass and project a short distance above its surface. The china base is provided either with or without connection plates for the fitting wires, which can thus either be screwed under terminals in electrical contact with the line wires, or be soldered direct to these. The nozzles are fitted with an insulating lining.

Standard wood pattrasses are provided to screw on to these nozzles, to which they are finally secured by a lock nut. The fittings are then merely screwed on to these pattrasses by means of ordinary wood screws.

Having now described the system from the point of view of its mechanical and practical possibilities, we may proceed to discuss its electrical qualities. Of course, here we are at once met by a difficulty; the prevailing question now is: Are rules required or not? There are a great many, including, we believe, the makers of this conduit, who advocate the partial—if not total—abolition of rules. The question of rules is now more or less *sub judice*, but as wiring contractors have at present to conform to certain regulations, the discussion of any system of wiring in comparison with other systems should be confined to its suitability for installations under existing rules, however obnoxious these may be. To discuss the claims of a system which would necessitate an almost complete suspension of existing rules, is a wider matter, and we will deal with this later on.

The insulating conduit system of wiring in its original and, let us say, professed form, aims at no very insidious breaches of the usual rules and regulations. In fact, the only point about it which may be said to clash with orthodox ideas, is the indirect encouragement to use wires with thinner insulation than is customary; however, we are anticipating. In comparing the system with other systems, we may discuss its claims under four headings, viz., mechanical strength, incombustibility, insulation, and convenience in wiring.

To take the first, and considering, of course, only other metallic conduit systems, we have in the insulating conduit as much mechanical strength as is likely to be required under most conditions. Of course, it is not as strong as gas piping, as the metal is not so thick; but for all ordinary requirements, such as resisting nails and screws, or supporting pendants or other fittings—it is no doubt amply strong enough.

The next point—incombustibility—is of more importance, and this is one to which the makers lay great claim. Naturally, it is not contended that if there were a fire *outside* the conduit the wires inside would avoid their fate any more than in the case of gas piping. But in the latter system, if an arc due to short-circuiting or to a "dead earth" occurs within the pipe, and the current of the arc is not sufficient to melt the controlling fuse of that circuit, there is no doubt that a hole would ultimately be burned in the gas pipe, and this has been known to occur. However, in fairness to gas piping it must be pointed out that these accidents are only reported from America where careless wiring is, or was, a bye-word, or else have been experimentally made with a view of demonstrating what *could* happen if the wiremen were wicked enough to neglect ordinary precautions.

Assuming for the moment that these same wiremen had been using insulating conduit, it is contended that the insulating lining is of such a nature that an arc would be rather discouraged and ultimately put out. Granted that the insulating lining is not combustible, and also that it has good insulating qualities, it is not quite clear to us how we could get a "dead earth," provided always that the makers could guarantee *absolute continuity* and homogeneity of the insulating lining. If, however, a workman is sufficiently careless as to scrape the insulation off a wire there is no reason why he should not equally well damage the insulation inside a box or conduit. And although the experiment is instanced of a match inside a thick roll of paper, it must not be forgotten that the match wants oxygen to continue burning—whereas the arc does not; and we therefore see no reason why—always granted that the careless workman is a factor in the case—we should not get a "dead earth" in the insulating conduit which would burn a hole in the metal. But, and this is the crux of the whole matter, if the makers can guarantee absolute continuity of the insulating lining, such a thing as a "dead earth" and consequent burning of the metal casing would seem to be impossible, and if a short circuit occurred it is possible, as is claimed, that the wires themselves would fuse and burn out long before the insulating lining were damaged. Taking all things into consideration, insulating conduit may be said to have distinct advantages over other conduits in respect to inherent safety from fires, and to offer the careless workman only half the opportunity for displaying his talents that other conduits do.

Let us now turn to insulation, with, of course, its converse—leakage. In gas piping and other bare metal conduits, in order to guard against leakage, and to bring the insulation resistance up to the high point required by the authorities, infinite precautions must be taken to prevent abrasions of the insulation of the wires, and surface leakage from fittings to the metal of the conduit. Besides which the pipes condense moisture in the interior, which tends to deteriorate the rubber on the wires. By using insulating conduit it is claimed that wires with less insulation may be drawn in, firstly, because the pipe has an insulating lining; and secondly, because the interior is so smooth that there is no fear of abrasion, and less resistance due to friction. Also, as the conduit is lined with a substance which does not conduct heat, the tendency for moisture to condense is greatly minimised, if not altogether obviated. It is not stated how surface leakage is to be prevented, but we are afraid we must, in this case, fall back on the workman again. With good, although thinly insulated wire, careful workmanship, absolute continuity of the insulation, no condensation, and a minimum of surface leakage, there is no doubt that insulating conduit approaches nearer to the ideal under existing rules than other forms of metal conduit. But—and we must always look at the other side of the question—supposing the contractor were wicked enough to rely on the insulating lining of the conduit to such a degree that he thought he could save money by putting in an inferior class of insulated wire (Manchester methods of inspection are not yet universal), and supposing also that, even if the insulating lining had not got damaged anywhere, the work were being carried out in an unfinished building as is often, if not usually the case. It is then more

than likely, indeed, it is probable, that lime and other foreign substances would get into the conduits and boxes, and also that water would get into the open boxes. What is there then to protect the wire from rotting, even if it be of the best quality, and what will prevent pole to pole leakage or surface leakage along the interior of the conduit to the first "earth" it can find?—most likely an outlet box. Still it would seem that even granted all these disabilities, the insulating conduit would offer less opportunity for leakage to earth than an ordinary bare metallic conduit, and if sufficient care were taken it would offer considerable advantages in the matter of insulation over other systems.

We next come to a not unimportant question, namely, convenience in wiring. Under this heading may be included accessibility and cost. As regards accessibility, the system has no special advantage over any other well-designed system of conduit; in fact, the inspection bends and crossings of another system we know of are a distinct improvement on the usual closed fittings of this and the gas-pipe system.

In the matter of cost, however, no direct advantage is claimed for insulating conduit, as it is clear that a pipe with a lining must be more expensive than a pipe without a lining. In other ways, such as upkeep, durability, and ease in fitting together, there is no doubt that insulating conduit can hold its own, although the fact that wires with less insulation can be used is no special advantage in the matter of cost, for the pipe has to be larger by the thickness of the insulating lining, and therefore more expensive in proportion.

Speaking generally, and presuming that the system is *carefully* installed under good supervision, we think that it can well hold its own against systems of bare metallic conduit, especially in regard to insulation resistance and safety from fire. The only point on which we are not assured is the question of continuity of insulating lining. Wherever there is a joint in a pipe, or a connection to a box or coupling socket, there must be a break in the insulating lining which would admit a film of moisture. Besides this, it is claimed as an advantage that when the pipe is cut or screwed the burr is embedded in the insulating lining, and so offers no risk of tearing the insulation of the drawn-in wires. But this embedded burr must be a weak point in the insulating lining, especially as some splinters must come very near the surface, and one or two weak places like this would be like the weakest link of a chain—a criterion of its strength.

The foregoing general review of the system as it appears to us is, as we have remarked, based on the assumption that the insulated conduit would have to be installed under existing fire office and electric supply rules, to which it would have to conform as well as other systems. Before leaving this standpoint it may not be out of place to consider some of the arguments put forward by Mr. Bathurst in his address to the Incorporated Association of Municipal and County Engineers last year on the subject of insulating steel conduit. In the first place we cannot help thinking that the author employs the electrical fire bogey a great deal too much, and if his statements with regard to insidious electrical fires were to come generally to the ears of the nervous consumer they would rather tend to defeat the object he has in view, namely, to point out that by the employment of insulating conduit the fire risk would be lessened. Although this is no doubt quite probable, it seems to us that every electrical engineer should make it his aim in life to minimise the so-called dangers of the electric light in the eyes of the consumer, and impress on him the fact that nothing can be good which is too cheaply paid for, instead of terrorising him at the expense of the whole trade, when it is evident that even the most perfect system of wiring is not perfect unless the workmen are also perfect.

Electrical fires were, we believe, at one time quite a common thing in America, but they are hardly known here; and where they have occurred, the cause has generally been found to be bad work and not bad material. Fires have most frequently occurred behind fuse or switchboards, and, perhaps, where dry jointing has taken place, and in all such cases the overheating which has resulted must have been due to insufficient fusing. The author does not seem to believe in fuses, because their capacity may be altered by unauthorised persons; but then this is no argument against fuses, any more than it would be an argument to say that razors should not be sold because people sometimes cut their throats. It has also not been found necessary to introduce automatic devices to prevent gas escaping, and the person who lights a match when he smells gas does so entirely at his own risk. It hardly seems necessary, therefore, to introduce fuse holders which will only allow one size of fuse to be inserted—although such things have been made by Messrs. Siemens & Halske—and the person who inserts a copper wire fuse in place of a tin wire deserves no more sympathy than the man who ties down a safety valve. The tendency of the age is to have everything done for us, but surely man may be allowed the use of a little common sense—which he can only gain by experience.

Mr. Bathurst next proceeds to enlarge on the deleterious effect of moisture and other things on insulations as generally used for coating wires, and the net result he arrives at is, that the wires must be protected by some form of enclosed casing, to wit, a tube, and in this and his denunciation of wood casing we are sure that most are agreed. Casing has, so to speak, taken such deep root in the electrical wiring trade that there are, no doubt, many people who would open their eyes if they were told that wood casing is hardly anything more than an unnecessary adjunct to insulated wires. Certainly, it does not fulfil any of Prof. S. P. Thompson's requirements enumerated before.

(To be continued.)

THE POST OFFICE AND TELEPHONY.

By S. ALFRED VARLEY.

(*Concluded from page* 531.)

A Brief History of Telephony.

The telephone was introduced into this country in 1877 by its inventor, Graham Bell, and the Bell Telephone Company was formed shortly afterwards. Later on the Gower-Bell Telephone Company was created, and this latter company was granted the right to manufacture and sell "Bell's receivers" (paying royalties for doing so), but they were not permitted to establish "exchanges" excepting by special agreement with the Bell Company.

Now, as is well known, the Post Office went to law with the Bell Company, and obtained a legal decision, declaring that the telephone was a telegraph instrument within the meaning of the Telegraph Act, and having been successful in their contention, it was very naturally assumed that the Post Office would at once take telephony into their own hands and largely develop it.

The Bell Telephone Company smarting under the verdict which had been given against them, but still holding patent rights, said that they would not supply telephones to the Post Office, and advantage was taken of this by certain smart financial men who controlled the Gower-Bell Company. What they did was to promote a fresh company to whom they undertook to supply "Bell receivers" which their agreement with the Bell Company permitted them to do, and as this fresh company were not bound by any covenants with the Bell Telephone Company, they would be free to supply apparatus to the Post Office and also to establish telephone exchanges, but for the rights they were to acquire, they were to pay to the promoters of the company, if my memory is to be trusted, over £300,000.

When the prospectus of this third company was issued, ligation was immediately threatened on behalf of the Bell Telephone Company, and the public being advised of this by newspaper advertisements held aloof from subscribing capital. The astute promoters being thus thwarted came to terms with the Bell Telephone Company, the prospectus was withdrawn, a new one of a company jointly promoted was issued, and within less than a week the capital asked for was subscribed six times over. The third company so successfully floated confined themselves to supplying telephone apparatus and telephone plant; a fourth company, the National Telephone Company, being formed, which came to terms with the Post Office. All these companies, so far as the investors were

concerned, were, for all practical purposes, promoted by one set of financiers, and each fresh promotion meant financial hauls made by the promoters and an increase of capital invested, so that the National Telephone Company was handicapped by over-capitalisation at the very beginning of its career, but the Mephistopheles of the piece morally responsible for this over-capitalisation was really the Post Office.

It is only right to say that as the above history is written solely from memory, although I think it may be relied on as being substantially correct, it is quite possible that I may have made a few errors in matters of detail.

The first telegraph company incorporated, viz., the "Electric and International," was not allowed to divide among its shareholders more than a 10 per cent. dividend, but they were granted certain statutory rights to facilitate carrying out their operations, such, far example, as wayleaves, &c., but the National Telephone Company have, I believe, been very much hampered in this respect, and consequently they have been involved in difficulties as well as an increased expenditure.

The privileges which have been conferred on the Post Office were granted with the idea that they would be employed solely in the general interest of the country, but how have these powers been used since telegraphy has been a Government monopoly?

So soon as the Telegraph Act had come into force, the Post Office, not content with having the monopoly of the telegraphs and the command of the highest legal talent of the country, proceeded at once to forge machinery which would still further increase the despotic powers they had been put in possession of. What they did, was (1) to retain in the same way as barristers eminent Fellows of the Royal Society; (2) they retained similarly the leading telegraphic and some of the ablest of our civil engineers, and in this way they obtained a most powerful weapon for aggressive purposes, which they were not slow to make use of.

The telephone invented and introduced into this country by Graham Bell in 1877 was outside the provisions of the Telegraph Act, nevertheless having might on their side and the command of leading scientists as special pleaders, the Post Office obtained a legal decision in their favour, and the Bell Telephone Company had to submit to the terms imposed upon them by their all-powerful, grasping opponent.

The invention of Graham Bell originated an altogether new industry of the greatest value to the commercial world, and the pioneering company ought to have received every consideration at the hands of a Government Department, but instead of receiving any encouragement, the Post Office swooped down upon them, and having succeeded in getting telephony into their own hands, they shirked the responsibility of undertaking the pioneering work themselves, and from their standpoint the Post Office acted wisely in so doing. Later on they granted licenses, but they compelled the licensees to pay *10 per cent. out of their gross earnings for the privilege of pioneering telephony*, and then complaint is made of the high rates charged, and the inefficiency of the service. In self-defence the licensees combined, and by doing so they obtained a monopoly, and in the long run the British public have to pay the piper, but the blame should be laid to the account of the Government monopoly, and the way it has been worked, and not to the directors of the National Telephone Company, who have done their best under the circumstances in which they have found themselves placed, and have been only able to earn for the shareholders what cannot be considered an unreasonable dividend.

Now, it should not be forgotten that the Telegraph Bill, as originally drafted and introduced by a Disraelian Government, simply provided for acquiring such rights as the then existing telegraph companies were in possession of, the final shaping of the Bill, however, devolved upon a Gladstonian-John Bright Cabinet, a Government who were ever proclaiming that they had nailed the flag of free trade to the mast, and yet it is to them that the country is indebted for the reintroduction of protectionism in a very ugly form, viz., in an important internal industry of British origin, and which was pioneered by private enterprise.

The monopoly of telegraphy and telephony should never have been granted to the Post Office, and the only common sense way out of the deadlock, as it seems to me, is for the Government to abandon the monopoly of telephony and telegraphy.

It requires no prescience to foresee that if the Postal Department are allowed grants of public money and a free hand to deal with telephony that history will repeat itself; they will incur, before they are done, probably an expenditure of £12,000,000 or more, the interests of which alone, at 3 per cent., will be £360,000 per annum, and after this expenditure has been incurred, the Government will find themselves compelled to do telephonic work, as is the case with telegraphy, at less than cost price, and the loss will have to be made up by the British taxpayer.

The late Mr. Torrens, when member for Finsbury, strongly expressed the opinion that the history of the purchase of the telegraphs ought to be written, and if anyone capable of doing it would undertake the task, it would, I think, open the eyes of Englishmen.

Now, what I would suggest under the present condition of things, is that before the country's money is voted on telephony, that a clear statement of the capital sunk in telegraphy, the accumulated loss which has been incurred on account of interest on the capital sunk, should be made out and laid before the members of the Legislature; the annual and the total amount of loss arising out of transmitting telegrams at less than cost price should also be clearly set forth, and also the amount which the National Telephone Company has been compelled to pay for pioneering telephony, and if this be done, I think Parliament will agree with the late Lord Playfair, who was the Postmaster-General at the time the Telegraph Act was passed, and for some time later, that "there never was a greater mistake than making telegraphy a monopoly."

Apart from what has been already stated, there is the moral aspect of a Government-trading monopoly which deserves grave consideration; but I cannot go into this matter here beyond pointing out that since the discovery of the dynamo principle, electro-dynamics has largely dominated all physics. And now, thanks to the telegraph monopoly, we have seen the chief electrical adviser of the Post Office not only dominating telegraphy and electrodynamics generally, but wielding, also, in no small degree, the scientific patronage of the country, and the demoralisation which has overtaken leading scientific men, and scientific societies also, as a consequence of making so important a branch of applied science, as is that of telegraphy, a Government trading monopoly, is simply lamentable to all those who have the true interests of science at heart, and who regard science as the elucidation of physical truths.

Since November, 1897, I have directed the attention of the Postmaster-General to what I consider to be grave scandals; among other things I have called attention to is what may be described as the Post Office booming of wireless telegraphy, and which resulted in the registering on July 20th, 1897, of a wireless telegraph company, capital £100,000, £75,000 out of which was to be paid to the promoters of the company, for that which we are told science is going to do, and I pointed out to the Postmaster-General that so long as the electrical executive were apparently allowed *carte blanche* in the matter of spending public money over wireless telegraph experiments, and were allowed to play the wireless telegraph bagpipes, and keep the fundamental note continuously sounding by means of inflated accounts of experiments being carried out by the Telegraph Department, and also through the medium of sensational lectures and press interviews published throughout the length and breadth of the land, in which it was asserted that their experiments demonstrated that electrical waves, through space, could be practically transmitted to any distance—that sounds which has been transmitted through interplanetary space had already been recorded on the phonograph, that the holding electrical communication with "sentient beings" in Mars "was not" the wildest of dreams, and further, that telegraph poles would soon be things of the past, and also that submarine cables would no longer be necessary in the near future. Now, whilst such turgid matter was allowed to emanate from the telegraph executive, and was published to the world with the apparent sanction of the Postmaster-General, there was a fair prospect of the Wireless Telegraph Company being successfully floated,*

* We happen to know that the writer has entirely misunderstood the relations between the Post Office and the Wireless Telegraph Company.—Eds. Elec. Rev.

but I am pleased to think that since I brought this and other matters also under the personal notice of the Postmaster-General, the prospects of science receiving a cheque on account for £75,000 are now not nearly so good as they once were.

STARTING A NEW STEAM PLANT.*

By EGBERT P. WATSON.

It not unfrequently happens that new steam plants are put in use with the greatest possible dispatch. Owing to a rush of business or delay in getting the new engines and boilers, so soon as they can be set up in place, the boilers are fired and steam turned on the piping at full pressure at once. Then there is hurrying to and fro with wrenches and caulking tools and all the appliances of the trade to stop leaks that would not have appeared had a proper course been pursued. A steam plant is a complex structure, and until the strains caused by changes of form from expansion and contraction have been adjusted or taken up gradually, there will always be trouble, and lasting derangement if too great haste is made to start. The course that long experience has shown to be the safest in the end is indicated in the advice here given.

Take the case of the tubes and tube sheets of a firebox boiler. So soon as a fire is started, the tubes, tube sheets, and side plates are exposed to great heat, if the fire is urged, in a short time, and while the rest of the boiler is cold, or at the temperature of the air and contained water, whatever that may be. In boilers of defective circulation or none at all, this variable temperature may be maintained for hours, and it requires no imagination to see that the effect upon the boiler is injurious, to say the least. The tubes are stretched tightly between two rigidly fastened sheets of greater or less thickness, with the result that something must give or buckle, when they are heated, to the extent of the expansion at least. This applies to the side sheets and stay bolts as well, and from this brief citation it follows that, when a new boiler is started for the first time, discretion is certainly the better part of valour. Not unfrequently boilers which have been well-constructed in the first instance, a good job in all parts, have been practically ruined, or, if that is a little too strong an expression, very much injured by haste in putting them into action. More harm has been done by the "hurry-up" plan of starting a new steam plant than persons without experience can conceive. Not only the boiler suffers, but the brickwork and front also, if the boiler is an externally fired one.

When a new boiler is fired for the first time, a boy's bonfire on the grates for 10 or 12 hours is ample heat. The water should not be allowed to get over blood heat, or about 100°, and this temperature should be steadily maintained all day. Upon no account should any steam be formed, the boiler being allowed to cool slowly at night. For the second day the heat should be increased to 200° and maintained at that stage for 10 hours, the heat and vapour being permitted to circulate through the whole of the pipe system. On the third day steam should be raisd to 10 lbs. and kept at that all day. If this plan is followed, the changes of form which take place will occur slowly instead of violently when a contrary course is exhibited, and all the expansion strains absorbed or redistributed without bad results. On the contrary, if fires are forced from the start there may or may not be visible local leaks, but the probabilities are that in the near future various disturbances will appear which might have been avoided by less violent measures upon the start. On the third day also the boiler should be thoroughly cleaned by feeding and blowing at frequent intervals. During the process of construction much dirt of all kinds accumulates; since black oil is used in quantity for drilling and tapping holes, a greasy sludge will be formed and settle on the cooler parts of the boiler, unless it is removed before it has time to settle. Not only upon the cooler parts, but upon other parts as well. If the circulation is active, this sludge is carried around until it happens to hit some place that it sticks to. When that occurs, no water can get beneath it, but heat from the other side of the plate can; when that occurs, the plate is overheated and the steam pressure forces the sheet down, making a bag, or pocket, that has to be cut out promptly and the sheet patched. This danger is supposed to be imminent in old boilers only, but it is by no means unknown in new boilers but a few weeks old.

It not unfrequently happens that new boilers are started with no water supply aside from the contents of the boiler, but it seems needless to say that this is a dangerous proceeding. If from any cause leaks of importance should start, or many small leaks, the only course possible would be to haul the fire or fires at once. This might or might not be feasible, according to circumstances, but an ample water service should be assured before the fires are started, and at least two sources of feeding the boiler when at work—an injector and a steam or power pump. Injectors are fickle things, especially new ones. If a slight air leak is present in the suction, they promptly quit work, although the leak is not apparent to the eye. All new boilers are liable to foam from the grease in them, and an injector will not work then, because it needs dry steam, not hot water, to act properly. The writer was much bothered by a high pressure injector refusing duty recently (225 lbs. steam pressure), and only got it to act at last by binding all suction joints externally with red lead putty. After this was done there was no further trouble. The joints were not practically air-tight, although they seemed to be.

The time to pack all valves, joints, and stuffing boxes is before the start; not after it. Much confusion has been caused by neglecting this apparently minor detail, if there is any such thing as a minor detail about a steam plant. Above all things, keep the man with the handy screw wrench from tightening up leaky joints under pressure. Upon no account should this be allowed, even with so low pressure as 10 lbs. A bolt that leaks may be a bolt that is broken, and the least twist upon it sets it free. After that anything may happen. The writer once saw a bolt blow out under 200 lbs. pressure, and as it left a considerable area undefended, one bolt after another ripped off until the pressure was reduced by the area opened. If a man had been trying to tighten that leaky bolt, he would have been killed. Again, a blow cock of only half-inch diameter leaked so badly that a man undertook (contrary to advice) to tighten it. As soon as he touched it with the wrench it promptly blew out and he had a badly scalded hand as the result. Fittings are sometimes caught by two or three threads only, the man at work on them having heard the whistle blow before he got through, and forgotten to screw them up afterward. The best time to make all changes and adjustments is when the boiler is cold. It cannot do any harm then.

Look out, too, for the man who supposes things about a steam plant. Suppositions in lieu of personal knowledge are dangerous and cannot be tolerated. With all the precaution which can be exercised, accidents may occur; they are quite likely to happen when only lukewarm vigilance is observed, instead of absolute personal inspection of every detail under pressure.

* *Scientific American.*

RELATION BETWEEN THE HEAT GIVEN OFF INSIDE VOLTAIC COUPLES AND THE HEAT CAPABLE OF BEING TRANSMITTED TO THE CIRCUIT UNDER THE FORM OF CHEMICAL ENERGY.

By Dr. D. TOMMASI.

Joule and Favre have shown that the electromotive force of the voltaic battery has a close connection with the heat generated by the chemical reactions in the battery itself, and that a whole series of questions relating to the currents could be treated after the manner of calorimetric problems.

Thus, then, the electromotive force of a battery is in proportion to the heat given off by the chemical action, and consequently, knowing the calories given off by this chemical action we can arrive at a knowledge of the work that this battery is capable of producing.

Favre however, remarks* that the heat brought into play

* *Traité des Piles Electriques*, by D. Tommasi, p. 60.

during the combustion of the hydrogen produced in the electrolysis is or is not transmissible to the circuit according to the nature of the compound which furnishes the oxygen required for this combustion. Thus, for instance, out of 131 calories given off by a couple (H_2O_2) formed of bioxide of hydrogen and hydrochloric acid, only 41·6 calories would be capable of being transmitted to the circuit and these would consequently represent the energy of the battery.

Favre, moreover, found that in the sulphatation of the zinc of a simple couple (zinc-platinum and diluted sulphuric acid), 39 calories are brought into play, but that, out of this number only 29·8 are capable of being transmitted to the circuit. Therefore, 9 calories remain imprisoned in the battery. From this last fact it follows that two of these couples would not decompose water.

In short:

29·8 cal. + 29 8 cal. < 69 cal.*

Now, I have found that the decomposition of water took place in accordance with what might have been expected if all the calories given off by these two couples had been transmitted to the circuit.

In short:

39 cal. + 39 cal. > 69 cal.†

38 cal. + 38 cal. + 1·4 cal. > 69 cal.‡

If the water of the voltameter is acidulated with hydrochloric acid, the decomposition of water takes place with greater facility, as can easily be understood, as we know that the electrolysis of the dilnted hydrochloric acid absorbs, for two molecules (2 × H Cl.) 66 calories, instead of 69 calories. But, even in this case, there should not be, according to Favre, any electrolysis, for:

29·8 cal. + 29·8 cal. < 66 cal.‡

According to Favre two zinc-platinum and hydrochloric acid couples would not decompose water if it is acidulated by $SO_4 H_2$, and would electrolyse it if it was rendered acid by Cl H.

In short, in the first case, we should get

33·4 cal. + 33·4 cal. < 69 cal.§

and in the second case

33·4 cal. + 33·4 cal. > 66 cal.

In fact, two of these couples do not decompose the water if it is acidulated with sulphuric acid, but decomposition takes place if the water is acidulated with hydrochloric acid. A couple consisting of zinc-platinum and diluted hydrobromic acid would give off, according to Favre, 35·9 calories, but only 29·9 calories would be capable of being transmitted to the circuit. Consequently, two of these couples do not decompose water if it is acidulated with sulphuric acid, but decomposition takes place if the water is acidulated with hydrochloric acid. A couple formed of zinc-platinum and hydrobromic acid, would give off, according to Favre, 35·9 calories, but 29·9 calories only would be transmissible to the circuit. Consequently, two of these couples would not decompose water acidulated either by $SO_4 H_2$, or by Cl H, for in the first case we should get

29·9 cal. + 29 9 cal < 69 cal.,

and in the second case

29·9 cal. + 29·9 cal. < 66 cal.

If the water in the voltameter is acidulated by $SO_4 H_2$, we observe decomposition commence, but it soon ceases. With the water of the voltameter acidulated by hydrobromic acid the decomposition is more active, in this case it is not the water that is decomposed but the hydrobromic acid itself.

In short, whatever may be the degree of dilution of this acid, we always see hydrogen given off at the cathode, whereas at the anode there is no gaseous escape, we only see a yellowish thread of bromine forming round the wire of the anode. This fact is easily explained, since two molecules of hydrobromic acid (2 Br H) absorb 59 cal. in order to decompose, whereas a molecule of water absorbs 69 cal.; now, *it is always the compound that absorbs the least heat that tends to be decomposed in preference by the voltaic current, but on the condition, however, that the reaction can be commenced.**

According to Favre the chromic acid couple† would give off 117·3 calories (2·5 volts) but only 65·5 calories (1·35 volt) would be transmissible to the circuit. It follows, then, that a single chromic acid couple would not decompose water acidulated with sulphuric acid.

In fact, if the positive electrode of this element is of platinum, the water is not decomposed but if the electrode is of carbon or spongy platinum there is electrolysis.

The chemical reaction produced within this couple being always the same, I have endeavoured to determine approximately, by means of electrolysis, what is the number of calories transmissible to the circuit by the chromic acid couple, according to whether its positive electrode is of platinum, carbon, or spongy platinum.

The following is a summary of the results I have obtained:—

1. The chromic acid couple, as Favre used it, *i.e.*, with its positive electrode of platinum, only produces an internal chemical work corresponding to about 65 cal. (1·4 volt).‡

2. By substituting for platinum, in the same couple, carbon or spongy platinum, we can render about 85 calories transmissible to the circuit (1 8 volt) or 20 calories more than the preceding couple.

It follows, then, from these last experiments, *that the electromotive force of the same couple varies according to the nature of the positive electrode.*

I have observed a similar fact with the following couple:—

Magnesium-platinum and dilute sulphuric acid.§ In short, this couple, according to the thermic data, should decompose water since the heat given off by the action of the magnesium on the dilute sulphuric acid is higher than the heat of decomposition of water,

112·8 cal.‖ > 69 cal.¶

Nevertheless, the decomposition did not take place. The same is the case if we substitute for the platinum of the magnesium battery, copper or silver, but if we employ in this element as positive electrode a cylinder of graphite or retort coal, the electrolysis of the water takes place.

According to Gore the electromotive force of the couple formed of magnesium-platinum and dilute sulphuric acid is 1·92 volts corresponding to 88·3 cal., and consequently far above the heat of decomposition of water (69 cal.) and yet, as we have just seen, water is not decomposed by this couple.** Now it has always been admitted that there is equivalence between the calories transmissible to the circuit and the electromotive force of the voltaic battery.

How is it, therefore, that there should be an exception in the case of the magnesium element?

It is very difficult to explain this anomaly, unless we assume that in this couple there are not only calories imprisoned within the battery (as Favre had found), not transmissible to the circuit, but also that among the calories transmissible to the circuit, there are some which act, if I may so express myself, electrically and some chemically. I cannot at present work out these ideas, but I hope soon to return to this important question.

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* Heat of formation of water.

† According to the thermic data of Favre.

‡ Calculated according to Dr. Tommasi's law of thermic constants.

‡ The electromotive force of a couple consisting of amalgamated zinc and diluted sulphuric acid is higher than a couple with non-amalgamated zinc by about ·7 cal.

§ According to Favre this couple would really give off 34·8 cal, but only 33·4 cal. would be capable of being transmitted to the circuit.

* For further details see the *Traité Théorique et Pratique d'Electrochimie*, by D. Tommasi, p. 464.

† This couple consists of an outer vessel of glass containing an amalgamated zinc dipping into the water acidulated with the sulphuric acid, and of a porous jar containing the following mixture: chromic acid, 25 grammes; water, 50 cubic centimetres; sulphuric acid, 10 cubic centimetres.

‡ It will be observed that the number of calories transmissible to the circuit given by Favre, is pretty close to the one I found by quite a different method.

§ The employment of magnesium in batteries was proposed for the first time by D. Tommasi in 1865.

‖ The heat given off by the action of magnesium on dilute sulphuric acid.

¶ The heat of formation of water.

** See the *Traité des Piles Electriques*, by D. Tommasi, p. 148.

JOEL ELECTRIC MOTOR CARRIAGE.

Our illustration shows a new form of electric motor carriage, elegant in appearance, and of light weight. It runs very smoothly and noiselessly, and it is stated that owing to the way the motors are carried, there is little or no vibration.

This carriage has been introduced by the National Motor Carriage Syndicate, Limited, of 37, Walbrook, London, E.C., to exemplify their patents for electric motors, and an under-frame for carrying same, the invention of Mr. Henry F. Joel, A.M.I.C.E., and for storage batteries, the invention of Mr. S. A. Rosenthal, both motor and battery being the result of many years of experimental research and practical trials, with the special object of making them exactly suitable for traction purposes.

The difficulty in designing a motor carriage to look as unlike a carriage requiring a horse to complete the effect, is a great one. There must be the necessary seating accomodation for two or more people, including the driver with a cover to protect them from the weather, the whole carried on three or more wheels. The ordinary brougham is the embodiment of the all-time past experience of these requirements. In addition, room must be found for the storage batteries and motors, and the carriage must be constructed of sufficient strength to carry their additional weight, whilst the motor must be conveniently arranged to exert its power. The carriage illustrated is considered by the makers to be the most successful attempt yet made to meet these requirements.

The electric motors, two are used in this carriage, are of comparatively very light weight, and slow speed, as well as of high efficiency—three most necessary features. They are constructed with internal stationary field magnet cores of steel, having 12 poles arranged to interspace equally round a circle with the armature revolving on the fixed axle outside the poles. The field coils are wound centrally upon the core, and are almost entirely enclosed by the steel core and poles, thus utilising their greatest possible magnetising effect. The armature is made with laminated iron rings having holes for the wires. The winding of the armature is also novel and very effective, it gives the least possible waste in the connecting and non-active parts of the wires, whilst the active parts are utilised to the best effect for economical working.

The following are stated to be the actual working data of these motors :—

Type.	Nominal B.H.P.	Speeds revs. per minute.	Weight of motor in lbs.	Electrical efficiency.
JM²	2	600	112	80 to 90 % according to load.

These motors will run at quarter speed, 150 revolutions per minute, half 300, and full speed 600, as required for the carriage. They are made to give 50 per cent. more B.H.P. for short periods, and will give 100 per cent. more power, or 4 B.H.P., if pressed.

Carbon contacts or brushes are used on the commutators, and the motors will run either forwards or backwards without sparking.

The two motors, as will be seen from the illustration, are placed under the carriage, a little in advance of the back wheels, which partly screen them, and they are not in any way unsightly. The motors are completely encased and weather tight.

The under-frame is one of the most important features of this carriage. It is made of steel tube, to form a rectangular frame suspended on springs, and connects the front and back axles of the carriage together; it takes the place of what is known to coach-builders as the "perch bar." This frame carries the two motors quite independently of the carriage, so that no vibration or shock in the carriage

is minimised when the motors are started, or stopped, or when running. At the same time the frame is perfectly resilient under all conditions of the road, rough or smooth, and the motors and gear, whilst being kept in constant distance and tension are elastic, and free to give under stress, such as rough jolting, or sudden strain due to temporary excess of electric current. In practice, this frame has been found to safeguard the motors from jar or shock.

The two motors drive the two back wheels independently, one to each wheel, by means of ordinary bicycle chains. The revolving armatures have small sprocket tooth wheels fixed on one side, and the chains gear with these and then over a larger wheel or rim pulley fixed to the spokes of the back wheels and thus propel the carriage. The outside of these larger pulleys are cased with leather, and the chains drive the carriage wheels by friction just as a leather belt would do, the chains in this case acting as endless metallic belts, with the exception that the small sprocket wheel on the armature gives a positive drive to the chain. In other carriages introduced by the syndicate both wheels have teeth for the chain in the usual manner. This special driving before described, however, has been found to be very efficient, convenient for turning, and to give enough grip to propel the carriage up hills of 1 in 8.

It is claimed that the advantages of using two motors are the saving of the balance gears, whilst the slow speeds, 300 to 600 revolutions per minute, entirely obviate the necessity for the usual intermediate speed reduction gear, and thus both weight and loss of power from friction are saved. The two motors also allow convenient control of speeds, and are self-adjusting for turning round corners, the motors automatically giving the difference in speeds as the turning movement requires.

The syndicate believes this practice of using two slow speed motors directly geared to the two driving wheels is the simplest and most efficient means of electric propulsion, and marks a great step in advance.

The storage batteries are arranged in four boxes of 10 cells in each, or 40 cells in all. Two boxes go under the front seat, and two under the back seat, and are not noticeable. Each box of 10 cells weighs under 2 cwt., and is easily handled and taken in or out of the carriage.

The batteries are made with pasted plates, and the paste is so constituted that whilst it is claimed to give the greatest efficiency of active material, it yet retains its shape and hardness on the plates. The supporting grids are specially designed to allow free expansion and to avoid sulphating from local action. These cells, we are informed, have been submitted to most searching trials for over six years on carriages, cycles, boats, and in portable electric miners' lamps, and such a thing as sulphating is almost entirely unknown in these cells.

The following gives the particulars of the cells used in this carriage, viz. :—

Weight complete cell.		Normal rate of charge.	Capacity in ampere-hours at		Watt-hours of complete cell at 20 amperes discharge.		Remarks.
			20 amperes discharge.	40 amperes discharge.			
Lbs.	Kilos.	Amperes.			Per lb.	Per kilo.	
22	10	20	140	120	13	28·6	17 watt-hours per 1 lb. of plate only.

Total weight of 40 cells, with boxes complete, 8 cwt.

The controller has some distinct features. The action is simple, there being three speeds only; first, slow speed, about 4 miles an hour; second, 8 miles an hour (about the speed of a fast "Hansom"), whilst the third gives 12 miles an hour. These variations are made by: first, by coupling the batteries in parallel with the motors in series; second, the batteries in series and the motors in series; third, and finally, the batteries in series, and the motors in parallel, methods that are well known. The controller also gives slow speed backwards. There is a special quick contact break to each of these changes, so arranged that only at the last moment of "making" or "breaking" is the change effected, thus ensuring perfect connection without sparking. The contacts are placed round a disc, with vertical spring contact arms.

This carriage will take three inside passengers, and a driver outside; the step up is easy, and there is ample head room. The total weight of the carriage is about 20 cwt.

With the batteries fully charged it is claimed that the carriage can travel 50 miles on good ordinary roads. The current used at the intermediate and usual speed being 20 to 40 amperes at 40 volts pressure, and this will last for 6 to 7 hours at a speed of 7 to 8 miles per hour, the total current consumed being 8 to 10 units. The current required to re-charge the battery being 10 to 12 units, which at 2d. per unit makes the cost for current 2s. for each run of 50 miles, or at the rate of ½d. per mile run.

The driver has a foot brake applied to the two back wheels. This brake has a double use. When pressed it acts upon a switch in the main circuit, and puts in resistance between the "on" and "off" contacts, so that the current is reduced as the brake is partly put on, and finally broken when the brake is hard on. This is useful, as the driver, after he has set the controller to the required speed, need not alter it, but can do all his regulating with the brake.

It is claimed that the distribution of the weight of the batteries equally over the front and back wheels, and the method of independent driving of the two back wheels, has greatly to do with the reduced weight of the carriage, the strains are equally divided, and the carriage is of lighter build than usual, and less power is required to run the carriage alone, and that, again, means reduction in weight of batteries, motors, &c.

Many trials have been made with this carriage on long journeys, up and down hills, and it has been thoroughly tested. The batteries have also been most carefully examined from time to time after long runs, and experience has demonstrated the suitability of the whole apparatus for electric motor carriages. Many favourable opinions and testimonials have been given of the comfortable travelling, freedom from noise and vibration, and this is a remarkable feature of this carriage, and is a great advance upon any known electric or oil motor carriage.

The syndicate do not propose to make or supply complete carriages, but simply to supply the electrical equipment, motors mounted in place on the under-frames adapted for any carriage with simple attachment to the front and back axles, and ready for the carriage-builder to design and build his work upon. Batteries ready in sets to go under seats, and controllers ready to fit for the driver, with full instructions how to apply them, and practical tuition afterwards in their use.

The complete carriage with electric motors, batteries, &c., were constructed for the syndicate by Messrs. Henry F. Joel and Co.

THE INDUCTION COIL SPARK ANALYSED.

To those engaged in exact investigations where the induction coil spark is made use of, it is of the utmost importance to know the real nature of the discharge and its origin. A contribution by Walter* (who has recently done much good work in elucidating the theory of the induction coil) throws a great deal of light on this subject.

Colley, Walter, and others have shown that the spark of the induction coil does not consist of a single discharge, nor, in properly constructed coils, of a series of discharges alternately in opposite directions; it consists, indeed, of a series of three or four discharges, but all in the same direction. The time interval between these successive discharges depends on the frequency of the oscillations in the primary circuit, and, according to measurements made by Walter on 30 cm. coil, amounted to $2{\cdot}7 \times 10^{-4}$ second. Assuming that besides the initial spark there were four after discharges, the total time occupied by single spark discharge would be $10{\cdot}8 \times 10^{-4}$ second. The break used in Walter's experiments was a very rapid one, making 25 breaks per second. The whole time occupied by a single spark discharge was

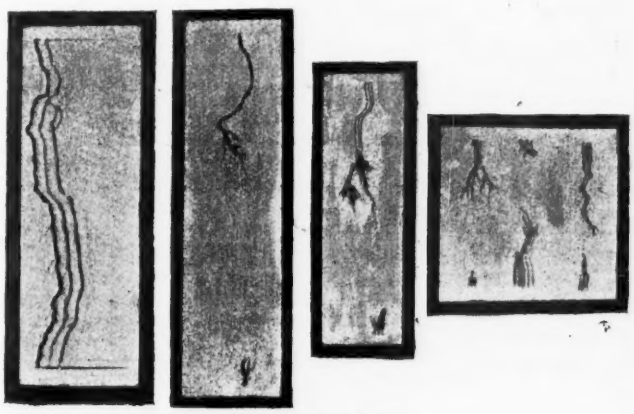
* *Wied. Ann.*, 66, p. 636.

therefore $\frac{10{\cdot}8 \times 25}{10{,}000} = \frac{1}{37}$ nearly of the time interval between two successive sparks. The discharge of a coil with 25 breaks per second would appear to the eye to be continuous, and yet electric energy would be radiated during only $\frac{1}{37}$ of the whole time.

The apparatus used by Walter to analyse the spark was somewhat different from the revolving mirror arrangements usually employed, and gave much sharper photographs. A photographic plate, 24 cm. long and 6 cm. broad, was mounted on a small carriage running on rails, the plate being fixed in a vertical plane parallel to the rails. Two platinum electrodes, one of which was vertically above the other, were focussed on the plane of the plate. The carriage was propelled by a weight connected to it by a cord passing over a pulley, the weight being arrested by a support just before the plate came into the field of the lens. The carriage would thus possess a constant velocity during the exposures, if we neglect the small amount of friction. The velocity was so regulated that two successive sparks would be photographed on the plate. Knowing the speed of the break (25 per second), and measuring the distance (which amounted to 10 cm.) between two successive images, the velocity of the plate could be accurately determined, and the time interval of the other phenomena shown by the photographic image, measured.

Fig. 1 shows the photographic image taken in this way of a spark passing vertically between the two platinum points. After the initial spark, which is by far the most brilliant, follow four after discharges. The appearance of the ends of the sparks on the plate (unfortunately this is not clear on the reproduction) showed that all the discharges were in the same direction. Carbon and other electrodes were tried, but it was found that the best results were obtained with the platinum electrodes.

In the course of his investigations, Walter made a discovery which throws new light on the way in which the electric spark arises. He found, in fact, that the spark is



Figs. 1, 2, 3 and 4.

not formed at a single leap across the air gap, but is preceded by several more or less abortive attempts to create a path for itself through the dielectric. When a spark just missed fire, the photographic image obtained was of the nature of that which is somewhat imperfectly reproduced in fig. 2. Two or three discharges in rapid succession pass partly across the air gap, terminating in each case in a branching brush discharge. The spark from the positive electrode penetrates to a much greater distance than that from the negative electrode, as can be seen from fig. 2. Each successive partial discharge penetrates a little further than its predecessor, and if there is sufficient energy behind the discharge, a complete path is finally formed across the air gap.

Knowing, as we do, that the passing of an electric spark through air dissociates the molecules in its path, and renders them temporarily tolerably good conductors, we can understand why all these rapidly following discharges follow exactly the same path. The interval between the preliminary partial discharges is only about one-seventh of that between the primary oscillations of the discharge; but this ratio changes very much under different circumstances. It is difficult to account for the number of separate discharges in the initial partial sparks. Fig. 3 shows the preliminary partial discharge when the capacity of the primary condenser has been increased. The separate discharges which make up the partial discharge are here better shown than in fig. 2.

Fig. 4 shows the partial discharges when condensers have been introduced into the secondary coil to give the discharge an alternating character. The longer positive discharge here appears alternately on opposite electrodes.

It is evident from these interesting experiments of Walter's that, as a rule, the electric spark is not formed at a single leap, but only after several abortive, and always increasing, partial sparks have formed a conducting path, across which the complete spark can travel.

THE MUNICIPAL TRADING MENACE.

Although the recent great struggle in the engineering trades was nominally fought upon the eight hours' question, the real point at issue was whether or not the employers should be masters in their own works. In this was also included the hardly less important question of a standard wage to be paid to certain classes of men. The principle which the employers then successfully maintained was that men should be paid fair wages according to ability and merit, and that the masters should manage their works in the way they thought most conducive to their successful operation.

This was a great blow to trades unionism, and it is not surprising that the unions should be continually striving to upset the present state of affairs.

The form in which they are now seeking to accomplish this end, and in which they stand the best chance of success, is in influencing the different trading municipalities in such a way that they employ their power of spending the public money to the advantage of the trades unions, and it need hardly be added to the manifest disadvantage of the ratepayers.

The manner in which this is brought about is by the Town Council or Vestry inserting what are known as labour clauses in their contracts.

At first sight, it seems only fair and reasonable that some sort of labour clause to prevent sweating should be inserted in every contract, and it is not hard for the few labour members forming the minority of nearly every Council to get a clause included by which the contractor undertakes to pay fair rates of wages, and to work the recognised hours. This innocent proceeding commits the Council to the insertion of labour clauses, and once started, these soon grow to an alarming extent.

At present very few of the great trades of the country are affected by this pernicious system, and it is therefore very difficult to get together a combination strong enough to fight the evil.

Electricity, in which we recognise the favourite form of municipal trading, is the first to suffer from the withering effects of this trades union policy. So vigorously have the unions worked among the local authorities that nearly all the new contracts contain objectionable labour clauses.

Unfortunately, manufacturers when let alone are apt to consider only their business, and do not devote sufficient time and attention to combating the dangers which surround them, and thus one contractor after another signs his name to conditions which are altogether unfair, which will paralyse his business in the future, which will so raise his costs that he stands no chance of competing in the world's markets, and which will be made still more stringent and objectionable in the next contract he undertakes.

The latest contracts, amongst other things, call upon the contractor to pay trades union rates of wages. This to begin with is altogether contrary to economical management. No capable employer would seek to underpay his skilled men, but he certainly would not give fitters' wages to an unskilled man using a file or turners' pay to a man doing repetition work on a lathe. Still, this is what the trades unions would

like and what the Councils are seeking to enforce through these unfair labour clauses. Worse even than this, the trades union conditions and wages are to be printed and posted up in all conspicuous places in the contractors' shops, and so what was once a contented commercial community is to be turned into a discontented and interfering body of workmen trying to usurp their masters' authority without bearing any of his burdens or risks.

For any and every breach the contractor is to be severely fined, to such an extent has this tyranny been pushed.

In some cases the manufacturers' position has been made still more difficult by the insertion of a clause giving the Council power to call upon him to appear before them with any of his employés to discuss the terms of their employment and the manner in which he conducts his business. Anyone reading this would say that such a state of affairs was impossible in a sensible trading community but it is nevertheless a fact, and these are the conditions to be found in several of the contracts which are to-day being advertised.

Since the above was written we have seen a cutting from the *Holloway Press*, reproduced below, which shows how this question has been dealt with by the Islington Vestry. It is very suggestive reading, and may possibly teach the labour party a much needed lesson.

A Progressive Revolt.

Two or three years ago Mr. G. S. Elliott raised a storm at a meeting of the Islington Vestry by declaring that the labour tail was wagging the progressive dog. With the accuracy or inaccuracy of that statement at the time it was made we have now nothing to do; but there is no possibility of disguising the fact that the labour tail did try to wag the progressive dog at last Friday's meeting of the Vestry and signally failed. The whole trouble arose from some awkward and unworkable clauses which the Vestry determined four years ago should be attached to contracts. Briefly stated, these clauses require that contractors should forward a schedule of wages paid, and should enter into agreement for the payment of the heavy penalty of £5 per centum of the total of the contract as liquidated damages in the event of any breach being proved. Four years' experience with these clauses have proved them unworkable, for Mr. Gordon, the chairman of the Electric Lighting Committee, which proposed to get rid of them, was able to show that they were practically a dead letter, and had been for some time. His proof was a bundle of contracts, in all of which these clauses had not been complied with. The position was very simple—the clauses were unworkable and bad in law. They were, therefore, useless and absurd. Their existence or non-existence in a contract did not in the least affect the principle of trades union rates of wages being paid to employés engaged in carrying out work executed under contract for the Vestry. The original intention of those who framed the clauses was to strengthen the position of the Vestry in securing the operation of the trades union principle. Experience showed that they did not have that effect. It was plain, therefore, that the sensible course was to get rid of them. But the Labour party attempted to block the way. That party wanted them retained. Every imaginable pressure was brought to bear on the Progressives, and the Labour tail tried its hardest to wag the Progressive dog. But the dog declined to be wagged—very properly too. Progressive after Progressive stood up, and backed by experience condemned the clauses as unworkable. But the Labour party fought to the bitter end, and were defeated, as they deserved to be. The unreasonableness of Mrs. Richardson and her friends in this matter was only too amply demonstrated in their expression of willingness to consent to the suspension of these clauses in regard to the Electric Lighting Station contract. Had the clauses been in the least material to the maintenance of the Trades Union principle, it would have been impossible to omit them from that or any other contract without prejudice to that principle. Public bodies may not play fast and loose with conditions to be attached to contracts. The conditions must in common justice be enforced and subscribed to in every instance, or they must be omitted. In dealing with contractors it is impossible for public bodies to have one sauce for the goose and another for the gander. Hence the Vestry was wise in declining to act inconsistently in regard to the clauses which were rescinded on Friday.

THE BALANCING OF ARMATURES.

By CLAUDE W. HILL.

In these days of drum armatures with turned cores, accurately planed or milled slots, and symmetrically formed windings, the amount of balance obtained in the ordinary course of manufacture is quite sufficient for the moderate speeds of revolution generally in use. Occasionally, however, we have to construct machines to run at unusually high speeds, and then it becomes necessary to test the balance of the armatures and attach counterweights if required.

The most usual method of testing the balance of an armature is to place it upon level parallel straight edges, when the heavy side is supposed to sink to the bottom, and counterweights are then attached to the opposite side of the armature until it will remain at rest in any position on the rails. In practice the writer has found this method unreliable and unsatisfactory, and the following figures will show the reason:—

Fig. 1 represents an armature 16½ inches diameter, weighing 10 cwt., and intended to run at 750 revolutions per minute. We will assume that it is out of balance to an

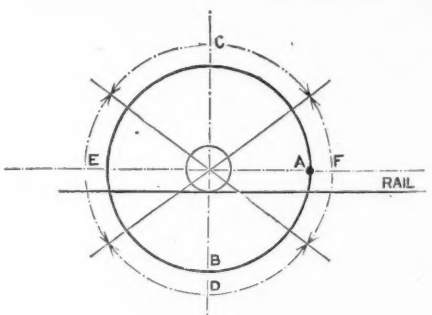


Fig. 1.

amount equal to a weight of 2 lbs. at the periphery on one side. When this weight is at the position, A, it will tend to sink to the position, B, and in doing so will exert a diminishing horizontal tractive force tending to roll the armature along the straight edges. The amount of the tractive force exerted at each point from B to A is shown on the curve, fig. 2. The force necessary to produce movement of the armature is shown by the horizontal line drawn on the curve, and we see that this line cuts the curve at 53°. Laying

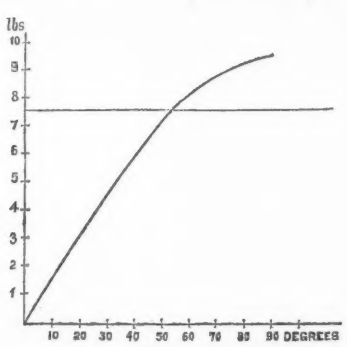


Fig. 2.

this out on fig. 1, we see then that within the arcs C and D the weight of 2 lbs. is insufficient to produce any movement of the armature, while within the arcs E and F the movement will be comparatively feeble and uncertain, especially if the armature has been running in the machine and the shaft has become slightly magnetised. By this method of testing this armature would therefore appear to be in sufficiently good balance. Upon being placed in the machine and run, however, the centrifugal force due to the unbalanced weight would be 263 lbs., which would be sufficient to cause considerable vibration, and possibly sparking and breakage of commutator connections.

A more sensitive way of testing is to place the armature on anti-friction wheels, themselves running on ball bearings. The heavy side of the armature would then fall much nearer to the zero position, although there would still be sufficient friction to prevent it getting quite there.

The best plan is to test with that force which it is our object to compensate, that is to say, the centrifugal force itself. To do this the armature should be mounted in bearings which are free to move, then while the armature is running the heavy side can be found with a piece of chalk

and counterweights adjusted on the opposite side until the cessation of movement of the bearings shows that the centre of gravity coincides with the axis of the shaft.

REVIEWS.

Kalkulos sobre las Kanerias de Agua. By A. E. Salazar. Santiago de Chili: Hume & Co. 1898.

This is a treatise by a Chilian professor upon the unification of the various formulæ for the flow of water in pipes. Among the formulæ considered are those of Prony, Darcy, Rankine, Coulomb, Trautwine, Flamant, and also the Thrupp-Robinson.

The book is embellished with numerous figures and tables, in one of which, of considerable extent, comparisons are worked out, for various formulæ cited or proposed, for different diameters and different values of the hydraulic gradient, the flow being in cube metres per second. Prof. Osborne Reynolds is credited with the authorship of the most complete formula for the frictional resistance of water in pipes, taking into account all the elements which enter into consideration, pipe diameter, roughness of surface, velocity, viscosity, &c. We note that the author throughout employs the letter *k* in place of the hard *c*, a usage which, we think, is novel and perhaps American, but it certainly gives a very Josh Billings appearance to the Spanish language, and seems to us not to be a desirable innovation, and we believe hardly academical; at least, we believe *k* is not recognised by the Spanish academy as belonging to Castilian Spanish, nor do we find it in a 1798 edition of Cervantes printed in Madrid.

Working of Steam Boilers. By Ed. G. Hiller. Manchester: Jas. Collins & Co. 1898.

This is a pamphlet sent out to steam users by the National Boiler Insurance Company, being instructions in the working, treatment, and attendance of steam boilers, for the use of boiler attendants and steam users generally. The boiler insurance companies generally are the repositories of information and data on which the present status of the steam boiler has been largely built up. The staff of a boiler insurance company changes too slowly to allow valuable experience to become lost, and much therefore becomes handed down to a continuous series of engineers. In this pamphlet such experience has been crystallised and put into a suitable shape for absorption by boiler attendants. We are glad to see that a note of warning is struck in respect to the much-abused hydraulic lift. The pamphlet is well illustrated with significant pictures of corroded plates, bad riveting, and collapsed flues. There are notes of warning against improper safety valve details, and also in regard to precautions before entering a boiler. It is so easy to be mistaken in removing a manhole cover. A very slight residual pressure in a boiler will blow off a loosened cover, and scald any one near. Such a pressure is easily held in by an ordinary safety valve, and no attempt should be made to open a boiler until some tap has been opened, and the actual absence of pressure absolutely proved by putting a wire through this tap to prove its clear thoroughfare.

The Law of Tramways and Light Railways. By Seward Brice, M.D., LL.D., Q.C. London: Stevens and Haynes, 1898.

This is a useful book, covering more ground than its title claims for it. The book is divided into four parts. Part I., containing some 190 pages, deals generally with company law, and is well worth reading by all those interested in the subject. Promoters of tramway undertakings, and those engaged in drafting private Bills in relation to these, will find plenty of useful material in that part of Chapter 1 headed "Capacities to be specially provided for."

Chapter 6, entitled "Tramway Undertakings," is for the most part of more or less general application, but the part on compulsory purchase is specially well dealt with, and goes thoroughly into the questions arising out of Section 43 of the Tramways Act, 1870, and the whole is clearly and concisely written.

Part II. is taken up with the Tramways Act, 1870, and the Board of Trade regulations, &c., in relation to tramways.

Part III. deals in a similar manner with the Light Railways Act, 1896, and the regulations with regard to light railways issued by the Board of Trade.

Part IV. is entitled "Precedents," and is composed of a number of forms of orders, special and general clauses for special Acts and orders and agreements and other instruments for tramway and light railway companies' undertakings.

Altogether the book is well put together, and will be found not only useful but interesting reading.

The Commercial Management of Engineering Works. By Francis G. Burton. Manchester: The Scientific Publishing Company, 1899.

From this book engineers may gain a general knowledge of the methods and ideas of purely business men, and we think that all engineers who are concerned in management will be able, if they grasp the ideas of the business man, to improve upon them. Our author has evidently a good knowledge of his subject, and makes a good many shrewed remarks. This is particularly noticeable in his observations on p. 115, relative to the trend of modern business in the direction of joint stock and the too great predominance of the mere banking, money-lending, dividend-seeking element, who labour for an immediate dividend, and are apt to overlook, perhaps unable to comprehend the necessity for technical knowledge in thinking out the future. We have ourselves observed the tendency of mind of the mere accountant in relation to new plant, and the expenditure of capital for the purpose of effecting economy. But we think that the author has all along had his mind fixed upon a large manufacturing establishment, and has rather written for such than for the class he appears to have intended in his opening remarks, namely, the young engineer and junior foreman. The subject is perhaps a difficult one. It is not easy to inculcate the principles of management. There is no scientific basis upon which to build, but at most certain hard and fast rules from which any departure may lead to disaster, second only to the disaster which will accompany rigid adherence to them. It is just in the knowledge of how far and when to make rules elastic that management comes in. Men cannot be managed by strict hard and fast rules, and it is in getting the most out of men that much of the prosperity of a business will arise. A manager must, says the author, have a capacity for justice, and he must be a firm disciplinarian, and stick to his decisions, carefully avoiding the contempt which workmen acquire for the jelly fish attitude.

If a manager sees fit to place his own son as a workman in the place, then as he sees fit to treat him, so he must treat all of his men. We see some works plastered over with rules to be observed. Now rules should be few, and they should be reasonable, and if thought worth hanging up, they should be enforced. If any rule is not enforced, it vitiates all the others, and if it appears good to overlook a rule at all frequently, let this rule be struck out. There is the rule against smoking in the pattern shop. Now this is repeatedly and openly broken by the managers, and brings contempt both on manager and rule. It is a rule which ought to be unbroken by everyone. There may be rules that the managers are obviously not to be tied to, but there are rules which should be imperative on all. To abrogate the smoking rule in the pattern shop is a fraud on the insurance company, while it may be permissible in the forge. On the whole this book, from the nature of the subject, is somewhat pedantic.

The Internal Wiring of Buildings. By H. M. Leaf. Archibald Constable & Co.

This little work can hardly be said to tell us anything new, and after perusal of the book it is difficult to determine whether it is intended to instruct the tyro, the working man, or the public. It cannot be called a treatise on the subject

with which it deals, but it may, perhaps, be intended for wiring contractors about to start business. But even a wiring contractor in the embryonic state hardly requires to have a lampholder or a cut-out described to him, although there may be many such who know very little more.

The book treats of many things, from the explanation of physical units to a wholesale quotation of electric wiring rules (indeed, a third of the book consists of the latter), but it cannot in truth be said that after digesting its contents the reader would be able efficiently to wire a house.

On the other hand, it contains many useful hints regarding various systems of wiring, and as we believe the author to be a wiring contractor himself, we cannot but commend his remarks on estimating, and his advice to the public to employ consulting engineers if they do not want to get "done" by the unscrupulous contractor. He condemns 10s. per point wiring in no measured terms, and fixes the real price at nearer 30s., and he also recognises the fact that more than anything else depends on the workmen employed.

There are some useful tables of conductors at the commencement, but we think it is rather misleading to speak of the current carried at 1,000 amperes per square inch as the *capacity* of conductors, as this term has another important meaning.

We must also take ojection to the definition of the ampere as the unit of *quantity* of current. Nevertheless the book is chatty, but it is a pity that the author did not go more thoroughly into the subject whilst he was about it, and with a more definite object in view.

The Engineers' Year-Book of Engineering Formulæ, Rules, Tables, Data, and Memoranda. By H. R. Kempe. London: Crosby Lockwood & Co. 1899.

This annually revised and excellent book has again been brought up to date by additions in the section of electrical power transmission and electric lighting by the introduction of matter relating to the utilisation of the waste gases of blast furnaces for purposes of power generation and transmission. There is fresh matter on locomotive counterbalancing, on springs, pressed steel trucks, &c.

Without turning over the whole 700 or more pages, the full extent of the additions cannot be inferred, as new pages are often inserted under an alphabetical suffix to their number, thus, 134, 134A, 134B, both these latter being additional pages. As hitherto, the printers have performed their task in the usual excellent manner.

CORRESPONDENCE.

The Absolute Block System of Signalling on Railways.

My attention has been directed to a letter by Mr. Christopher J. Little, in which that correspondent claims to be the inventor of the block system, and informs your readers that he has "demanded £50,000 from the Board of Trade."

Permit me to state that Mr. Little did not invent the block system, nor did he take any part in the invention.

Mr. Little gives the date as 1865, but the absolute block system was in use many years before that date, and I personally remember it in use on a section of the Midland Railway, and have ample proof of its early use upon other railways.

The claim of Mr. Little to a sum of £50,000 was investigated by Government some years ago when it was found that Mr. Little was *not* the inventor, and that his claim was not founded on fact.

Mr. Little states he is "now willing to accept any terms the Board of Trade think proper."

Your readers will agree with me that no Government or Board of Trade is likely to make any offer of terms to Mr. Little after the fact has been clearly demonstrated that he has no ground whatever upon which to make any claim, and no right to receive one single penny from the nation or other party.

Mr. Little evidently does not know what the "block rules are." It is quite a mistake to say that "if an engine-driver overrun the stop signal, he has the empty section in front of the signal."

This is not so, for as a fact "Line clear" is given according to rule when the previous train "has passed at least a quarter of mile beyond the home signal." If therefore a driver run past a home signal at danger he may expect to find an obstruction a quarter of a mile further on.

There is no Act of Parliament which requires the "empty section" as stated by Mr. Little.

Clement E. Stretton,
Consulting Engineer.

Saxe-Coburg House, Leicester.
April 3rd.

Trade in the Soudan.

An impression has hitherto existed that patents and trade marks registered in Egypt also cover the Soudan. In the interests of clients who had instructed me to procure trade marks and patents in these countries I referred the matter to the Foreign Office and also to the Agent-General in Egypt, and the Governor-General of the Soudan. I enclose replies from Lord Salisbury and Lord Cromer. They both appear to be of sufficient importance to warrant the publicity of your columns. I have not yet had Lord Kitchener's reply, but will take the liberty of forwarding it when received.

Benj. T. King, A.I.M.E.,
Registered Patent Agent.

[Copy.]

B. T. King, Esq.,
165, Queen Victoria Street, E.C.

Foreign Office,
27th January, 1899.

Sir,—In reply to your letter of the 20th inst., in which you ask for information with regard to the registration of Trade Marks in the Soudan, I am directed by the Marquess of Salisbury to inform you that your communication has been referred to Her Majesty's Agent and Consul-General at Cairo for his observations.

I am, Sir,
Your most obedient, humble servant,
(Signed) St. JOHN BRODRICK.

[Copy.]

B. T. King, Esq.,
165, Queen Victoria Street,
London, E.C.

British Agency,
Cairo, *6th February*, 1899.

Sir,—I am directed by Lord Cromer to acknowledge the receipt of your letter of the 28th ultimo, and to inform you that he has already received a communication on the subject from the Foreign Office. Lord Cromer is of opinion that it is, perhaps, a little early for considerations of this nature, but he has forwarded the correspondence to the Governor-General of the Soudan for his observations and for any steps which it may be possible to take.

I am, Sir,
Your obedient servant,
(Signed) RENNELL RODD,
Secretary of Legation.

[Copy.]

B. T. King, Esq.,
165, Queen Victoria Street, E.C.

Foreign Office,
18th March, 1899.

Sir,—Referring to your letter of the 20th January last, respecting the registration of Trade Marks in the Soudan, I am directed by the Marquess of Salisbury to give you the following information on this subject:—The question of the legislation requisite to prevent the fraudulent imitation of Trade Marks is at present under the consideration of the Government of the Soudan. The civil administration of that country is, however, still in an inchoate condition, and until Central Courts of Justice are created it would be premature to attempt the establishment of a register of Trade Marks to be used as a basis for civil actions.

I am to point out that it is distinctly laid down in the Soudan agreement (Article VIII.) that the jurisdiction of the mixed tribunals shall not be recognised for any purpose whatever in any part of the Soudan except in the town of Suakin. It follows, therefore, that no registration of Trade Marks before the mixed tribunals of Egypt can be held to protect the rights of their owners in the Soudan.

I am, Sir,
Your most obedient, humble servant,
(Signed) MARTIN GOSSELIN.

On Wireless (?) Telegraphy.

It may be well to study the following case:—If we have two exceedingly narrow vertical rectangles of wire, A B, C D, at a distance apart, and we make A B the primary, and C D the secondary, it will be clear that the induction will be a minimum, for the effect of B will be to neutralise the effect of A. Now, if we could do away with the return wires, B and D, or could remove them to an infinite distance, the effect of A on C would be a maximum. But we can realise this ideal case by making a slight alteration in our apparatus; we must increase the frequency and place a capacity at each end of the wires, A and C, the earth will serve for the capacity at the lower end. Here we see that we have a form of apparatus which bears a striking resemblance to that employed by Signor Marconi, and yet, it will be noted, we have arrived at this result by the old method without drawing upon Hertz waves or assuming either earth or air cur-

rents. So that it appears that the so-called wireless telegraphy is nothing but our old friend, the mutual induction of two wires, though in a somewhat disguised and altered form.

E. Bennett Viles.

High Voltage Circuits.

I noticed a letter in your paper a few weeks ago as to lamps in series on 220-volt circuits. While I would not think of putting eight lamps in series, as suggested by one of your correspondents, for hall and passage lights where 2½ or 3-C.P. lamps are sufficient, I have in many instances put two 110-volt or three 75-volt lamps in series, and I find that customers like them.

It allows three points of light for practically the equivalent cost of one 8-C.P. lamp.

Thus three landings can be lit at a very moderate cost. I also use 3-C.P. lamps of 60 volts, two in series, on a 120-volt circuit in my own house, stables, &c., and find them very useful.

You cannot buy 3-C.P. lamps to run at 220 volts, and I would strongly recommend this system of small candle-power lamps in series in suitable places.

J. E. Ritter.

Limavady, *March 31st.*

The Ambleside Tenders.

I am preparing on behalf of my firm a tender for the "Electric Supply Installation" of Ambleside, but I cannot satisfy myself as to how and when I am likely to get paid. May I invoke your friendly aid to induce Mr. J. S. Raworth, or some other expert in specifications, to express his opinion as to the manner in which the clauses referring to payment will operate.

A clear and definite statement on this subject will, I am sure, prove most valuable to many of my friends and competitors, as well as to

A Contractor.

Reply to "A Weekly Reader."—*Re* Patent Specifications. The charge for all specifications, whether illustrated or otherwise, is the same. See sub-heading to our "Abstracts of Published Specifications."

BUSINESS NOTICES, &c.

Announcement.—Messrs. A. & W. Hopkins inform us that they still carry on their business as suppliers of electrical goods at Clun House, Surrey Street, Strand. Through a misunderstanding, instructions were only given to insert the name of their manufacturing department (the London Electrical Fittings Company) in the current issue of the Universal Electrical Directory, to which fact they wish us to draw attention.

Bankruptcy Proceedings.—A receiving order has been made in *re* Daniel W. Paine, Gloster Road, Brighton, electrician, on debtor's own petition.

Upon the petition of a creditor a receiving order has been made in the case of J. E. Stott (J. E. Stott & Co.), electrician, of Bryam Arcade, &c., Huddersfield.

Notice is given of intended dividend in the case of Frederick Jones (F. Jones & Co.), St. John's Hill, New Wandsworth, electrical engineer. Last day for proofs April 11th. Trustee, Mr. A. Mackintosh, 24, Railway Approach, London Bridge.

At the London Bankruptcy Court on 28th ult. Mr. G. W. Chapman, senior Assistant Receiver, presided over the first meeting of the creditors of Messrs. Charles & Blackwell, electrical engineers, of Leicester and London. The debtor, J. S. Blackwell, presented the firm's petition, his partner having gone to America. He states that he has lived at Leicester for the past 28 years, and was in the employment of the Leicester Corporation Electrical Department. He started in business in partnership with Mr. Charles in October, 1897, having £25 each and £250 borrowed from two Leicester gentlemen, and still owing. The firm carried on business at 74 and 111, Church Gate, Leicester, and in London under the firm of the Central Electrical Engineering Company. The accounts filed showed gross debts £1,626, of which £1,373 is unsecured, and assets £571. The failure is attributed to the non-success in the flotation of the Steady Arc Lamp Company, Limited. On behalf of the debtor it was stated that there was no offer, and resolutions were passed for bankruptcy.

Electrical Wares Exported.

Week ending Mar 1st, 1898.

Port.	Value.
Adelaide	£23
Alexandria. Telep. mat.	77
Antwerp	29
Auckland	18
„ Teleph. mat.	2,740
Bangkok	447
Bombay	433
Boulogne	86
Buenos Ayres	520
„ Teleg. mat.	127
Calcutta	84
Cape Town	1,250
Constantinople	250
Colombo	100
Delagoa Bay	1,076
Durban	205
Flushing	25
Gibraltar	277
Lyttleton	2,597
Madras	10
Malta	72
Mauritius. Teleg. mat.	42
Melbourne	149
Passages	29
Port Elizabeth	135
Reval	62
Shanghai	7
Singapore. Teleph. mat.	44
Sydney	1,726
Tientsin	31
Wellington	112
Yokohama	488
Total	£12,945

Week ending Feb. 28th, 1899.

Port.	Value.
Amsterdam	100
Auckland	686
Bombay	55
Boulogne	61
Buenos Ayres. Teleg. mat.	321
Calcutta	1,186
Cape Town	829
Christiania	90
Colombo	185
Delagoa Bay. Teleg. mat.	338
Durban	62
„ Teleg. mat.	717
East London	77
Fremantle	279
Genoa	125
Gothenburg	21
Hamburg	300
Hobart	728
Hong Kong	13
Liban	60
Malaga	45
Malta	60
Montreal	61
Ostend	119
Penang	13
Perth	50
Port Elizabeth	40
Rotterdam. Teleg. mat.	27
St. Petersburg	11
„ Teleg. mat.	323
Stockholm. Teleg. mat.	130
Sydney	2,565
„ Teleg. mat.	266
Vera Cruz	13
Wellington	657
„ Teleg. mat.	2,090
Yokohama	475
Total	£13,177

Foreign Goods Transhipped :—

Rio Janeiro. Teleg. mat.	£1,024	Malaga. Elec. light apparatus	£280

Electrical Wares Exported.

Week ending Mar. 8th, 1898.

Port.	Value.
Adelaide	£13
Albany	45
Amsterdam	50
Antwerp. Electric fuses	174
Barcelona	12
„ Elec. light cable	1,170
Beira. Teleg. mat.	1,995
Bombay	40
Boulogne	32
Buenos Ayres	542
„ Teleg. mat.	115
Cape Town	1,216
Christiania	34
Colombo	17
Durban	101
„ Teleg. mat.	529
East London	594
Gibraltar	26
Gothenburg	76
Hamburg	121
Liban	60
Lisbon	935
Madras	1
Malaga	156
Melbourne	57
„ Teleg. mat.	695
New York. Teleg. mat.	1,654
Penang. Teleg. mat.	16
Port Elizabeth	411
Rosario	39
Santander	59
Shanghai	6
Singapore. Teleg. mat.	265
Stettin. Teleg. wire	91
Stockholm. Teleg. cable	365
Suez	12
„ Teleg. cable	140
Sydney	51
Tientsin	36
Yokohama	270
Total	£12,221

Week ending Mar 7th, 1899.

Port.	Value.
Adelaide	£38
Alexandria	18
Amsterdam	142
Boulogne	42
Bremen. Teleg. mat.	30
Buenos Ayres	763
Cadiz	10
Calcutta	201
Christchurch	13
Christiania	25
Colombo	41
Copenhagen	168
Delagoa Bay	206
Durban. Teleg. mat.	117
East London	1,099
Gibraltar	259
„ Teleg. instruments	1,530
Gothenburg	70
Hamburg	140
Hobart	137
Kobe	2,342
Launceston	98
Lyttleton	25
Melbourne	261
„ Teleg. mat.	946
Penang	20
Perth	178
Port Chalmers	31
Port Elizabeth	1,517
„ Teleg. mat.	773
Port Said	137
Rio Janeiro. Teleg. mat.	331
Rotterdam. Teleg. mat.	36
Santos. Teleg. mat.	113
Shanghai	469
Singapore. Teleg. mat.	161
Sydney	286
Wellington	148
„ Teleg. mat.	298
Total	£13,219

Foreign Goods Transhipped :—

Barcelona	£3,174	Durban. Teleg. mat.	£29
		Rockhampton. Electric light apparatus	71
		Total	£100

Books Received.—"The Slide Rule," by C. N. Pickworth, Wh. Sc. Fifth Edition. Manchester: Emmott & Co., Ltd.

"Measurement and Weighing," by Edwin Edser. 2s. 6d. London: Chapman & Hall, Limited.

Liquidation Notices.—The Electric Lighting Extension Syndicate, Limited, meeting at Bartholomew Works, Kentish Town, on March 8th and 24th, approved of an agreement for the sale of the undertaking to the Penny-in-the-Slot Electric Supply Syndicate, and for this purpose voluntary liquidation was resolved upon, Mr. C. O. Bastian being appointed liquidator.

Creditors of Easton, Anderson & Goolden, Limited, must send particulars of their debts, &c., &c., to Mr. W. B. Peat, liquidator, 3, Lothbury, E.C., by May 9th.

Creditors of Electricity, Limited, must send particulars of debts, &c., to Mr. P. W. Davis, liquidator, 61½, Fore Street, E.C., by May 2nd.

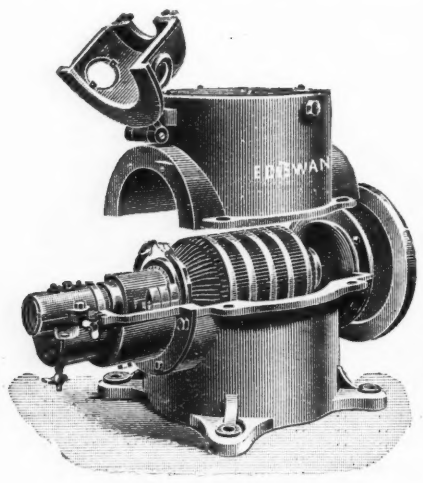
Bankside Dwellings.—The St. Saviour's (Southwark) Board of Works has resolved that if the City of London Electric Supply Company does not within one month commence to erect workmen's dwellings for the people dehoused several years ago, when the company's works were being built at Bankside, legal proceedings would be commenced without further notice.

Catalogues.—Messrs. Flather & Son, of Leeds, send us a nicely printed and illustrated list of their multipolar continuous dynamos and motors, the output and the various sizes being arranged in tabulated form.

The Campbell Gas Engine Company, of Halifax, has brought out a new catalogue (April, '99) of the Campbell oil engine, describing its main features, and by means of capital illustrations showing the various applications of this special type of engine to electric lighting, pumping, launch, and other work.

Prepared and illustrated in its usual excellent style, the Edison and Swan United Company has issued Section X. of its catalogue devoted to high voltage electrical fittings and accessories. A variety of incandescent lamps, the "cul-de-sac," division, anti-shock, and a number of other types of holders, also divers designs of switches and switch covers, ceiling roses, cut-outs, &c., are among the many things shown and priced.

Ediswan Enclosed Motor.—A new type of enclosed motor is being made by the Edison & Swan United Company. The body consists of two steel castings which form the enclosing framework and the magnetic circuit. They are accurately fitted together at a broad joint which in no way interferes with the perfectness of the magnetic circuit. The material is a specially soft quality of cast-steel, having a magnetic permeability superior to wrought-iron, thus reducing the weight to a minimum. Gun metal bearings are fitted in cast-iron brackets, which form the end pieces of the motor. These are of a particularly substantial design, the brasses being several times as long as the diameter of the shaft. Great stiffness is secured,



while at the same time accessibility to the wearing parts is not interfered with in the least. Most effective lubrication is brought about by capacious oil chambers cast in the lower parts of the brackets, capable of holding a supply of oil for a considerable time without refilling. The oil is drawn up by the action of two chains to each bearing and most effectively distributed over the rubbing surfaces by means of oil channels and carried back into the reservoir. The shaft is provided at each end on the inside of the bearings with oil-throwers which cast off any oil which may travel along the shaft into a guard so enclosed that all possibility of oil creeping into the main body of the motor is prevented. The commutator is made of hard drawn copper with mica insulation. The conductors are securely attached to the commutator bars and sweated therein in such a manner that they cannot come loose. The brushes are of electro-graphitic carbon having a very high conductivity and readily making a thoroughly good contact with the commutator. They are held in brush holders of a special design and can be easily replaced. The smallest motors have two brushes each side, the larger ones two or more according to the output. Any one brush is capable of being speedily removed while the machine is running, and all brushes can be adjusted individually for pressure on the commutator. It is claimed that there is no sparking at all loads, and the brushes are fixed in position, not requiring movement from no load to 20 per cent. over full load or more. All the brush gear terminals and internal connections are at once accessible by lifting the lid provided over the commutator box. In this way the machine may be rapidly disconnected in such a way that the upper half of the body may be easily removed with its own magnet coil attached, the connections being so arranged to the terminal board that a mistake can hardly be made in replacing them in their proper positions. Terminals are provided so that by following the instructions sent out with every motor, the direction of rotation can be at once changed, if desired, by re-arranging the connections on the above-mentioned terminal board; such change in direction and rotation does not necessitate a re-adjustment of the brushes. The wires for connecting the motor to the source of supply are passed in through ebonite glands in the commutator box which are placed opposite to the terminals into which those wires have to go. The armature is of the slotted drum type, the plates being securely attached to the shaft by means of gun-metal end plates and gun-metal spider, thus securing great freedom from eddy currents and consequent cool running. The armature wire is of thoroughly insulated highest conductivity copper. The magnet windings, also of the highest conductivity copper wire, thoroughly insulated, are on two separate bobbins easily detachable from the body of the motor, and being fitted with their own pair of terminals. The whole of the motor is designed also to stand 20 per cent. over load for an hour or more without any injury whatever. The parts are so proportioned that the energy waste in the motor is the least possible under the circumstances, and thus the motor is of very high efficiency. It is completely enclosed—dust proof; the commutator cover has a glass window in it for inspection.

Electrical Work in Russia.—A dispatch from St. Petersburg to the *Financial News* says that a syndicate is at present being formed for establishing and working electrical plants in Russia. The syndicate is said to control a capital of 20,000,000 roubles. It includes many important electro-technical concerns of central Europe and some great banking firms. Among the former are the General Electricity Company, of Berlin, the Union Electricity Company (Loewe & Co.), and Messrs. Siemens & Halske.

Extension of Patent.—Mr. James Dick, of Greenhead, Glasgow, is applying for an extension of patent No. 12,254, dated October 14th, 1885, and amended October 31st, 1893, granted to Robert Dick (of R. and J. Dick), for an invention of improvements in the manufacture of driving belts or flat bands, and in the means or apparatus employed. The application is announced for hearing by the Judicial Committee of the Privy Council on May 10th.

For Sale.—Particulars and conditions of sale of the stock-in-trade, goodwill, and patent interests of the Elieson Lamina Accumulator Company, Limited, Camden Town, may be obtained at the offices of Messrs. Caprons, Hitchins, Brabant & Hitchins, 7, Savile Place, Conduit Street, W.; Messrs. Vallance & Co., Lombard House, George Yard, Lombard Street, E.C.; and of Mr. R. Rabbidge, receiver and manager, 32, Poultry, E.C., and at the premises, 4, Greenland Place, Camden Town. The concern is to be sold by order of Mr. Justice Kekewich (Earl of Galloway [self and others] *v.* the Elieson Lamina Accumulator Company). Tenders have to be submitted to Mr. W. O. Hewlett at the chambers of Mr. Justice Kekewich, Royal Courts of Justice, by Wednesday, April 12th. See our "Official Notices."

Increase of Capital.—Messrs. Lahmeyer & Co, electrical engineers, Frankfort-on-Main, are increasing their capital from £200,000 to £300,000.

The Midland Electric Power Scheme.—A Birmingham paper draws attention to the present position of the scheme for the provision of an extensive installation of electric power in the manufacturing district of South Staffordshire and East Worcestershire, commonly known as the Black Country. The enterprise is promoted by a syndicate under the title of the Midland Electric Corporation for Power Distribution, Limited, and which will in due course be developed into a public company. The corporation made their application for powers in the session of 1898, and the districts scheduled by them are practically comprised in a circle having a radius of 7 miles from a point on the borders of Tipton and West Bromwich. The area within this circle, exclusive of a margin of Birmingham, is under the control of 28 local governing authorities. In two of them—namely, Wolverhampton and Walsall—the local authorities already possess electic lighting stations. Some of the others approach these towns in size and importance, such as the boroughs of Dudley and West Bromwich, but there are a number of others too small to contemplate a separate electric installation of their own, whether for lighting or for power, and their only chance is for some combined scheme, either on their own part or by the advent of a large trading body such as the Midland Electric Corporation. The chief difficulty of the promoters has been with the larger local governing bodies, who had already obtained powers of their own, and who preferred to wait for experience elsewhere. The company have, therefore, had to meet the opposition, so far as their respective districts are concerned, of the Corporations of Dudley and West Bromwich and the urban districts of Smethwick and Oldbury. These, of course, would be very important and valuable areas to the Electric Corporation, but inasmuch as the latter had secured the consent of a very compact group of districts, they thought it wise not to imperil their order by holding out for those which offered opposition. They accordingly dropped the opponents, and in August last obtained Parliamentary powers to deal with the remaining districts. The concession embraces about half the area originally contemplated, but it is the half which contains the greater number and the most compactly situated of the works which are likely to become consumers. In it are comprised the following:—The borough of Wednesbury, the urban districts of Bilston, Coseley, Darlaston, Heath Town, Rowley Regis, Sedgley, Short Heath, Tipton, Wednesfield and Willenhall, also the parish of Bentley in the rural district of Walsall. These have a population of 192,388. The district of Kirgswinford, with a population of 17,832, already had an order, but the District Council have agreed to transfer it to the company; while the basis of an arrangement has also since been come to between the company and the Oldbury District Council. Three other areas—namely, those of Amblecote, Quarry Bank, and Walsall Rural, have consented to a further application which the company are making in the present session. With these additions the company will have an area containing a population of 251,768. The company have concluded negotiations for the purchase of a site for a generating station on the West Bromwich side of Tipton, with ample canal

and railway facilities for the supply of coal, and from this no main or feeder to the outskirts of the district need exceed 8 miles in length. The engineer to the company, Mr. G. L. Addenbrooke, has recently visited the Continent to inspect the leading stations where operations such as those contemplated by the company have already been proceeding for some time on a large scale. Since his return the matter has been carefully considered by the directors, and plans are now in an advanced state for a station to be erected for the supply of the area over which powers have already been obtained. A commencement is proposed to be made with plant of 5,000 horse-power, but with arrangements to admit of easy extensions. The site chosen has an area of 30 acres, and the extensions can be readily carried to 40,000 horse-power if required. Before raising their capital the company are now engaged in a further effort to convince the authorities of Dudley, Brierley Hill, West Bromwich, Handsworth, Smethwick, Hales Owen, Lye, and Stourbridge that it would be to their interest to come within the scope of the scheme. Their plea in this direction is based on the consideration that electricity can be generated far more cheaply upon a large scale than upon a small one; and they are also willing to supply the current to the local authorities for lighting purposes upon a wholesale basis. The terms to which the company have agreed include the following:—For lighting purposes 6d. per unit for the first 100 hours of supply per quarter, and 3d. per unit for subsequent hours of supply, with discounts of from 5 per cent. to 20 per cent. where the consumption is over 100,000 units per annum. For power purposes the rates are to be 3d. per unit for the first 78 hours of supply per quarter, and ·825d. per unit for subsequent hours of supply. The company offer the current to local authorities for public lighting at 1·6d. per unit.

New Premises.—Messrs. White & Johnson have opened premises at 17, College Place, King's Road, Chelsea, S.W., as electric light fitters, &c.

The National Electric Free Wiring Company has opened premises in the Market Place, Redditch.

Removals.—Mr. F. Corbett, electrical engineer, has just removed from 19, Upper Baker Street, to 6, Baker Street.

Mr. George Porter, electrical engineer, has just removed from 14, Cullum Street, E.C., to 31, Lime Street, E.C.

Messrs. Meirowsky & Co. have removed from 10, Glasshouse Street, W., to 52, Queen Victoria Street, E.C.

Secret Commissions in the Electrical Engineering Industry.—The Lord Chief Justice (Lord Russell of Killowen) proposes, on the resumption of work by the House of Lords, to draw attention to the subject of secret commissions in trade and to introduce a Bill in order to deal with the matter. In the meantime the fact may be recalled that a special committee of the London Chamber of Commerce have made an investigation of the question and prepared a long report on the subject. A few extracts from an appendix to the report may not be without interest at the present moment. The first case is that of an electrical and mechanical engineer in the North of England. This gentleman writes:—"I have come into contact with several cases most prejudicial to the healthy development of trade generally, chiefly among the London engineers, who specify for particular makes of articles and that everything shall be to their approval in order to be able to press the contractor for money. Then there are consulting engineers of the highest standing and, above all suspicion, but in whose offices there are men who, unknown to their employers, receive indirectly or directly commissions, and who levy blackmail on the contractors." This is a serious indictment, but the following instances, which are cited by a consulting and electrical plant manufacturing engineer, are even worse. He says:—"I have, during the period I have been in business, come in contact with a large number of cases which undoubtedly come under the heading of secret commissions, and which have left upon my mind a strong impression that secret commissions are paid and received in every department of business and by almost every grade of men. In my numerous negotiations with local authorities I am constantly receiving intimation that I could make my path much smoother by availing myself of the services which members of corporations are willing to render for a consideration." A third case which relates to the lubricating oil trade of Lancashire and Yorkshire, is discussed by a gentleman thoroughly acquainted with the trade. He writes:—"In regard to cylinder oils, the engineer-stokers at mills have been so generally educated by oil-sellers and agents that they almost all expect an allowance of some sort on oil used. If not forthcoming complaints are handed in of inferior body or grit, and so forth. The amount of allowance varies, but it is now mostly about 3d. per gallon or 10s. on a 40-gallon barrel." The writer then refers to the blackmailing tactics of under managers and managers, and of storekeepers, and states that "the workers, such as engineer-stokers, nearly all belong to clubs, and regularly compare notes as to firms who are free in gifts or otherwise." He also mentions that the spokesman of a board of directors in negotiating a fresh contract said that "the former supplier always kept the board, for use at their meetings, with cigars; would the prospective supplier do the same?" The real question is as to whether any legislation could possibly diminish or mitigate any of the evils of which the above are only a few examples.

The "Surveyor" Exhibition. — The "Surveyor" Exhibition of road-making materials and appliances, to be held at the Royal Agricultural Hall in connection with the Building Trades' Exhibition from April 26th to May 6th, will include an exhibition of materials and plant, &c., for electric tramways so far as they affect the road surface. Mr. Handcock (Handcock & Dykes) is organising this section. It is considered that as all surveyors, chairmen of district councils, and roads committees throughout the kingdom receive invitations to this Exhibition, it forms an excellent means of placing the latest electrical appliances before them. Particulars may be obtained from St. Bride's House, Bride Lane, Fleet Street, E.C.; applications to be addressed to the "Surveyor Exhibition."

Workmen's Compensation.—Last week at Kilmainham a young labourer named Maguire sued Messrs Riter, Couley & Co., electrical engineers, Ringsend, Dublin, for damages for the loss of a toe while employed by them at a steam winch connected with the electrical power station. Defendants said they had done everything they could for him by continuing his wages and looking after him in hospital. The Recorder said that the case opened up a very serious matter. It would be a very big responsibility if a company were to be held liable to the full in the case of a boy who had just entered their service and who having met with an accident, was to become an absolute annuitant on their hands. It was a really startling proposition, and he only wished that Mr. Chamberlain could have been present in court. He added that no one had greater sympathy with the working classes than he had, but he was certain that no one would be disposed to urge that a company should be made to pay heavy damages under circumstances like this. The Act fixed a great responsibility, no doubt, on big industries, and he could not see that the injury caused to this youth was in any sense a permanent one, in the sense of depriving the plaintiff of the capacity of earning his bread, and he had a great difficulty in measuring what pecuniary loss this youth had suffered. He would under all the circumstances consider the justice of the case met by making a decree for £1 12s., with costs.

ELECTRIC LIGHTING NOTES.

Barrow.—Something like 6,000 lamps have been applied for in connection with the electricity undertaking. Application is being made to the Local Government Board for a £15,000 loan for extensions, as the present capacity of the plant is exhausted. It is only intended to spend £4,500 at present. The mains have been carried as far as Furness Abbey.

Barton.—The Board of Guardians have decided to apply to the Local Government Board for sanction to borrow £3,355 for the electric lighting of the new Union Infirmary at Patricroft.

Bermondsey.—In the House of Commons last week the Bill to confirm a provisional order made by the Board of Trade under the Electric Lighting Acts, relating to Bermondsey, was read a first time.

Blackrock.—The Urban Council has received a circular from the Municipal Industries Syndicate with reference to the electric lighting of Blackrock. It was ordered to be marked "read."

Canterbury.—A claim was made here the other day against the Corporation for injuries sustained through negligence in leaving the electric light trenches unprotected. Plaintiffs, who, with their horse and trap, fell into the trench, secured a verdict of £45 and £20 and costs respectively.

Last week a Local Government Board inquiry was held into the application for a loan of £13,250 for extensions to the electric light and dust destructor works. Mr. Hammond, consulting engineer, was present, and gave details of the proposals.

Chesterfield.—The following letter has been addressed to the town clerk:—

Chesterfield, *March 22nd*, 1899.

Chesterfield Electric Supply.

Dear Sir,—We desire to advert to the negotiation which passed between us while the General Power Bill was depending in Parliament, and to make the following proposition for the consideration of the Electric Committee of the Corporation:—Our clients will at once erect at their own expense suitable and sufficient plant to meet the electrical needs of Chesterfield, and will undertake to deliver current to the Corporation at the confines of the Borough for distribution in the town. They will be prepared to supply up to a maximum of 250, rising, say, in five years, to 500 horse-power (the town taking as a minimum one-tenth of this maximum load), at the price of 2½d. (two pence-halfpenny) per Board of Trade unit. Our clients make this proposition and quote this low price, in the belief which they confidently hold that electrical energy would come into much more general use in a manufacturing community if it were available at a lower price than it is at present. They are prepared to run a considerable risk in order to establish the feasibility of their system, and they will furnish all proper and adequate guarantees to the satisfaction of the Corporation of the permanence and sufficiency of the supply. They are willing that in case of difference all electrical matter should be referred to Sir Frederick Bramwell, Bart., or him failing, Mr. William Henry Preece, the electrician to the Post Office. You will at once see that by adopting this proposal Chesterfield will become the pioneer town in the matter of cheap electrical supply without the ratepapers having to provide the capital for the plant. Awaiting, as we hope, the favourable consideration of the Committee,

We are,
Yours faithfully,
(Signed) Davies, Sanders & Co.

Crewe.—The Local Government Board, before giving sanction to a loan of £26,000 for electric light purposes, has asked as to the suitability of the site, and the probable revenue from the new illuminant. It was stated that Mr. Hopkinson, of Manchester, the engineer of the scheme, had declared the suitability of the site, and that a canvass made as to the likely revenue from consumers of the light was satisfactory.

Deal.—The Town Council having received a report dealing with electric lighting for Deal and Walmer, has decided to adjourn the matter for the present, as the rates are already heavy.

Derby.—It has been arranged that in streets where the electric light mains have already been laid the gas lamps shall be converted into incandescent electric lamps, on condition that the cost to the Highways Committee does not exceed £1 per lamp, and that the charge for electric light does not exceed the present cost of gas.

Dublin.—Now that the new cables are being laid down in connection with the electric lighting, arrangements are also being made for changing from 100 to 200 volts. Current is transformed down from 2,000 volts at sub-stations, of which six have had to be provided. Formerly it was transformed down to 100 volts on consumers' premises. A new sliding scale of charges has been introduced.

Eastbourne.—It is stated that the Eastbourne Electric Light Company have agreed to sell their undertaking to the Town Council for £82,135, which represents £21 for every £10 share. Immediately the Corporation obtain possession of the works they will effect an extensive improvement in the electric lighting of the borough. The parades will be lit by a line of small electric lamps similar to those used at Dover. Electric trams may also be started in the town. The Council expect to make an annual profit of £1,500 from the undertaking.

Ecclesall.—The Board of Guardians will hold a special meeting with regard to the estimate for a proposed electric light installation prepared by Mr. H. W. Ravenshaw, electrical engineer, London.

Edinburgh.—The Town Council has accepted estimates to the extent of £5,003 18s. 4d., for work at the Macdonald Road power station. The Council also sanctioned £8,827 for the formation of the subway from Macdonald Road station up Leith Walk to Picardy Place. The whole of these estimates accepted were the lowest sent in.

Failsworth.—Mr. John Dugdill, electrical engineer, of Failsworth, was successful in entering the District Council at the election last week.

Grays.—The District Council is considering sites for electricity works.

Hanley.—The Electric Lighting Committee has reported that the borough surveyor and electrical engineer have submitted the annual statement of accounts in connection with the electric light undertaking for the year ended December 31st last, showing a balance of £376 12s. 7d. to be made up by the general district rate. The committee recommended application being made for a loan of £5,000 for the extension of cables in the borough, and the provision of transformers, meters, &c. The Council has adopted the report.

Hebden Bridge.—It has been decided to include in the renovation of Salem Chapel, Hebden Bridge, a complete installation of electric light. A new Baptist church, now erecting, is also to be lighted electrically.

Hull.—The Electric Lighting Committee has resolved upon main extensions in Great Thornton Street (£188), Hessle Road (£540), and Park Avenue (£145). The feeders in the Old Town system are to be increased at a cost of £450. The chairman of the Committee (Councillor Skinner) went over the financial state of the undertaking, and added that the Committee proposed granting an honorarium of 100 guineas to Mr. Barnard in consideration for his work in the design and erection, &c., of the new works which had been opened during the year at Sculcoates Lane. Mr. Barnard had saved the expense of a consulting engineer. The loans sanctioned work out at:—Old works (completed some time ago), £45,800; new works (recently completed), £40,690; new extensions (now being carried out), £26,000.

Italy.—A company has just been formed in Naples, with a capital of £200,000, to be known as La Società Meridionali di Elettricità, to put down a plant to utilise the water-power of the Tusciano River to distribute the electrical energy generated for power purposes to the many industrial concerns at Salerno and Torre Annunziata.

Keighley.—The Council's provisional order having been approved by the Board of Trade, the Gas Committee are taking steps to carry it into effect. Some Corporation property at Low Bridge has been selected as the site for the works, and an engineer is to be advertised for to prepare plans and estimates, and superintend the erection and running of the plant. An agreement has been arrived at with the Keighley Tramways Company for the supply of current for working the cars, and further negotiations are to take place. If the present idea is carried out, the Corporation will lay the cables, &c., and charge the company for the power at a fixed rate. There is a further question of cars. It is suggested that in the event of the company not caring to provide the cars the Corporation should do so, and lend them to the company at a rate which would meet the cost of interest and depreciation.

Kingstown.—The District Council has been considering an offer from the Municipal Industries Syndicate to light the town with electricity. The Council, though desirous of having the electric light, will take time to consider whether to accept the offer.

Llanrwst.—The Llanrwst electricity supply station was opened by the Right Hon. Earl Carrington, G.C.M.G., on Thursday, March 30th. His Lordship was met by a representative gathering from the town. Among those present were Messrs. C. Fred. McInnes, A.I.E.E., and A. E. Malpas, A.I.E.E., representing Messrs. Calvert & Co., the contractors, and Mr. E. R. Peers, A.I.E.E. His Lordship was escorted to the works in Watling Street. After inspecting the station, a short description of which was given by Mr. Peers, Earl Carrington, in a few well-chosen words, declared the works open and switched on the light. The switch handle used was of elaborately chased silver, and after removing, was mounted on an ebony and silver vase and presented to his Lordship by Mr. McInnes. The presentation was engraved with his Lordship's coat of arms and a suitable inscription. The company present then adjourned to the Victoria Hotel, and were entertained at dinner by the Llanrwst Electricity Supply Company. The contract for the whole of the work which was entrusted to Messrs. Calvert & Co., of Manchester, at the beginning of January, is now practically completed. Already over a mile of mains have been laid and connections are being rapidly proceeded with. The work throughout has been under the superintendence of Mr. C. Fred. McInnes, A.I.E.E. The cost of gas in the town is 5s. per 1,000, and the Electricity Supply Company expect to be able to reduce the proposed charge of 8d. per unit very shortly.

Lowestoft.—To-day a Local Government Board inquiry is to be held regarding various loans proposed to be raised by the Corporation, including £30,000 for electric lighting purposes.

Maerdy.—A provisional order has been granted to the Maerdy Electric Light Company, Limited, Rhondda Valley.

Newington.—At the last Vestry meeting the Electric Lighting Committee asked to be empowered to appoint the requisite working staff, the total amount for wages being estimated at £1,120 12s. per annum. The matter was referred back to the committee for a detailed report as to the staff proposed. The charges per unit are to be 6d. for the first hour, 4d. for the second hour, 3d. for any time after, and 2½d. for motive power.

Newport.—Electric arc lamps have been substituted for gas lamps in Maindee, Alexandra Road, &c. The Lighting and Traffic Committee is considering the use of incandescent electric lamps to replace gas lighting in other parts of the town.

Oldham.—The Electric Light Committee last week discussed a report from Prof. Kennedy on the proposal to double the pressure, so as to supply a larger area and obviate the establishment of branch stations. The present boiler power at the central station is insufficient for the engine room capacity, and it is proposed to procure four additional boilers. The new works, which have no connection with the tramway scheme, are estimated to cost about £20,000, and it is proposed to apply for borrowing powers for that amount.

Pontefract.—Last Saturday the Guardians instructed the Building Committee to take steps to light the workhouse buildings by electricity.

Rotherham.—A deputation from the Corporation has interviewed Prof. Kennedy, and now reports that Prof. Kennedy had made provision in his scheme for taking in tramways at any time; that it was advisable to defer the street lighting, as possibly the present lamp columns may be utilised; and that the site he had selected for the generating station was the best of the available sites he had seen.

Shoreditch.—At a meeting of the Vestry on Tuesday, Dr. Mansfield Robinson, vestry clerk, submitted the following important communication from Mr. C. J. Stewart, clerk to the London County Council:—"Some few instances have occurred in which the Council has approved the works referred to in notices served by electric lighting companies under their respective orders, as to which works the local authorities concerned have afterwards raised objections or have imposed conditions not quite in accord with those imposed by the Council. The Highways Committee, which advises the Council on such matters, has, therefore, directed that in order to secure if possible uniformity of action in future, intimation shall be given to the local authority concerned of every such notice served upon the Council, so that such local authority may have an opportunity of expressing its views before the Council's approval or disapproval is given to the works referred to therein. I am to point out, however, that as each order requires that the Council's approval or disapproval of works shall be signified within one month from the receipt of notice from the undertakers under the order, it will be necessary for the local authority to communicate its views to the Council as quickly as possibly with regard to the works referred to in any notice, and in every case within 14 days after the receipt of the intimation from this office of the service of such notice." It was decided to refer the letter to the Lighting Committee for consideration. Another long discussion took place on the presentation of the adjourned report of the Lighting Committee which recommended the Vestry to enter into an agreement for the supply of current for motive power purposes to the new printing works of Messrs. Wertheimer, Lea & Co. on special terms for a period of 21 years. It was contended during the discussion that it would be unwise for the Vestry to commit itself to an agreement for such a long period, and on a show of hands the recommendation was declared lost, thus shelving the matter for the time being.

Uckfield.—At the last meeting of the Rural Council, the committee appointed to consider the question of the application for a provisional order for electric lighting at Crowborough, reported that they did not consider it advisable at the present for the Council to apply for such an order, and that with regard to the proposed application for one from the Crowborough Gas Company, they were of opinion that that body should not be invested with powers usually given in a provisional order until they had obtained statutory powers respecting the supply of gas. They also recommended that the maximum rate per unit should be 6d. instead of 8d. as suggested. The report was adopted.

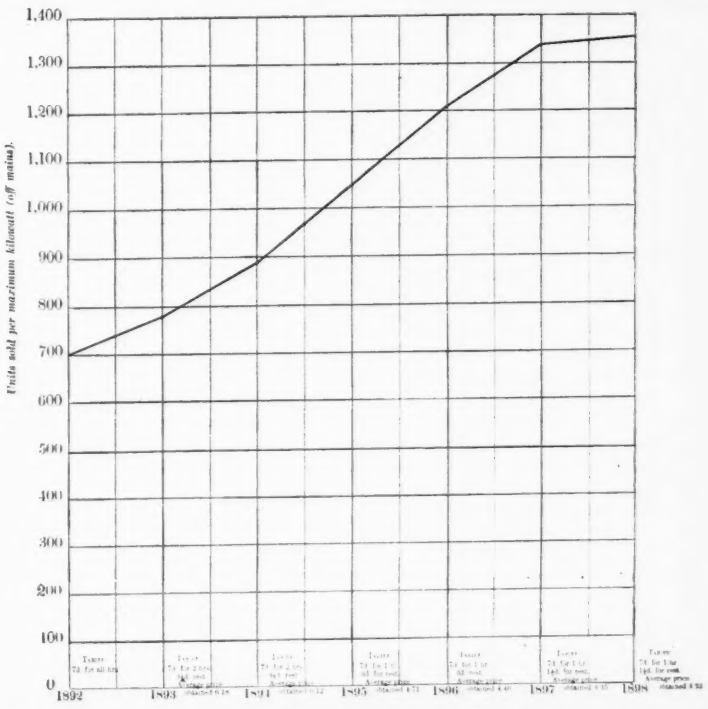
(*Continued on page* 557.)

THE DEVELOPMENT OF BRIGHTON ELECTRICITY WORKS.

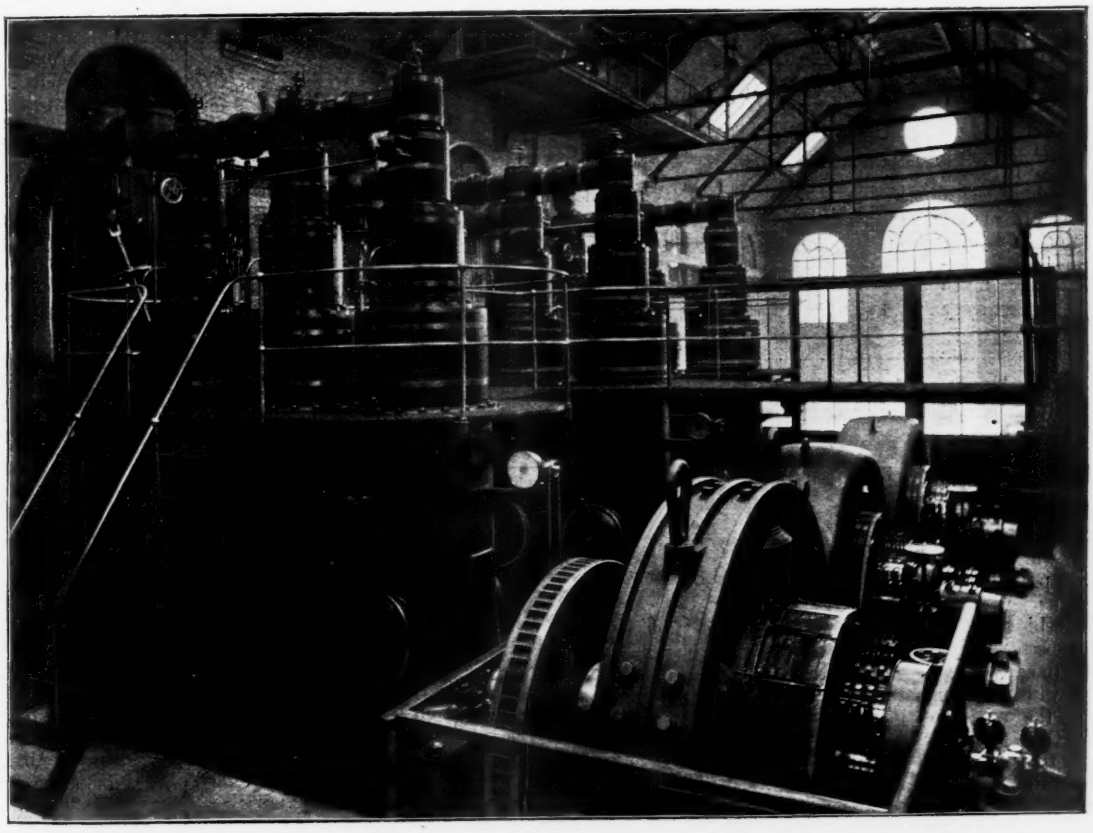
(*Concluded from page* 514.)

Brighton is, of course, a fashionable watering place, but it is neither the influx of visitors nor the shopkeepers who supply their needs, that are responsible for the commercial success of electric lighting, indeed, if the high-class residental districts of Brighton were to be electrically disconnected from the rest of the town, say, to become a portion of Hove, it would not prove in the slightest degree inimical to the electricity supply system; indeed, reasoning entirely from the conditions of supply, it ought to prove extremely beneficial.

We all recognise that it is very desirable to be able to supply electricity to each and every customer, no matter whether his demand may be regular or irregular, and make a profit out of him, but under the present conditions of electric lighting that is difficult; probably there may arise in the next few years an engineer who has sufficient confidence in storage to put down huge batteries of accumulators, and thereby reduce the standby losses, but as things are ordained at the present moment we are obliged to consider the economics of running machinery at varying loads.



Curve showing Units Sold per kw. Demanded.



The Multipolar Plant at Brighton; The Extensions are being carried out beyond this Plant.

Brighton has carried to a logical conclusion the principle clearly laid down by Mr. Wright, that it is not so much the electricity consumed as the period in which it is consumed. As the subject of the Brighton sliding scale of charges is of general interest, and as the Brighton Corporation has

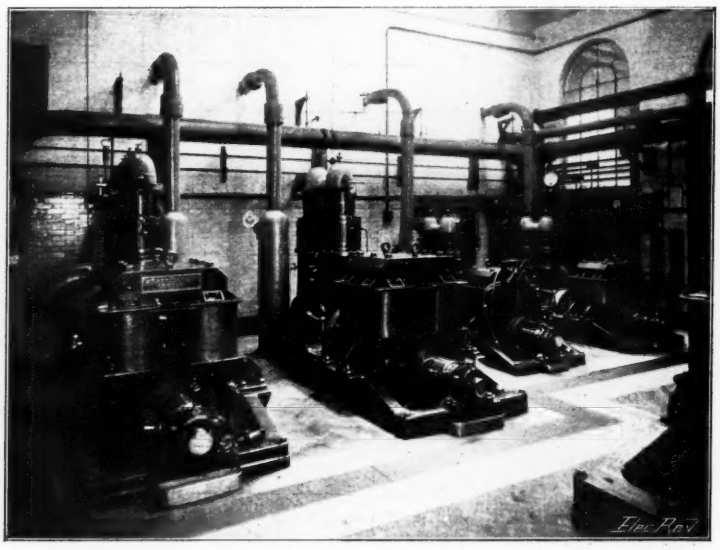
recently, on the advice of Mr. Wright, still further reduced the price of electricity, we will give some of the reasons that have led to this.

The principle of making a reduced charge after the initial costs have been covered has been adopted in a great many businesses in which the cost of getting ready forms a very large proportion of the total expenditure. Two familiar instances are the charges for telegrams and parcels post. There can be obviously no comparison between the supply of gas and water and electricity. In the latter case machinery and mains have to be more than equal to the greatest demand made on them during the year, even though the demand should only last a few minutes in the whole year.

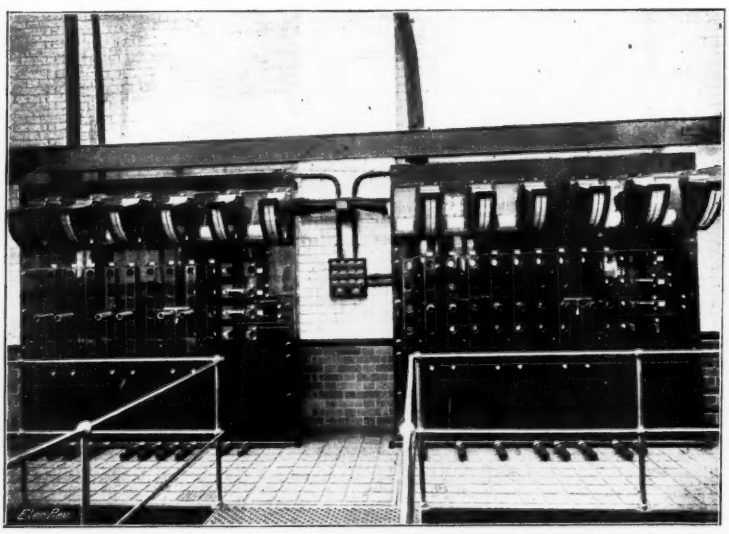
As a matter of fact it can be shown from the Brighton balance-sheet, that out of total net cost of £29,970, £25,541 was incurred by having to keep the machinery and mains constantly in a position to supply current when called upon to do so.

To put the matter in another way it may be said that in 1898 it only cost the Corporation three - fifths of a penny per unit to continue running the machinery after it had been once got ready to supply.

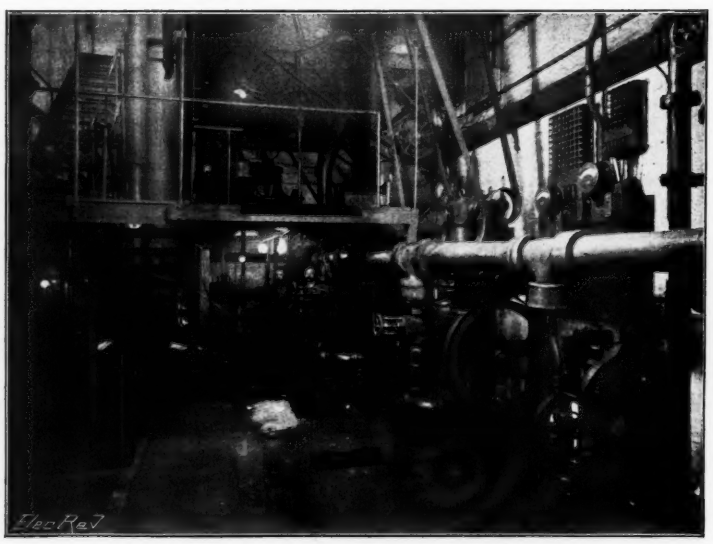
It will be seen from the analysis set forth in the subjoined table that the revenue derived from the electricity sold during the first hour and charged at 7d. per unit barely covered the cost of getting the machinery ready and producing that electricity. On the other hand, over £6,000 was obtained from the sale of electricity after the first hour's daily use, which cost only three - fifths of a penny per unit to manufacture, and produced in revenue 1½d. per unit.



The Small Units.



Switchboard at Brighton.



Auxiliary Plant.

Following this to its natural conclusion, the important fact to be borne in mind is to keep up the price of the first units, but by all means reduce electricity to the long hour customer. It is only by accepting such a principle in other towns that one may hope to see a wider adoption of electricity for motive power purposes. A good deal has been done we admit, but the field is still comparatively unexplored. During 1898 over 1,032,000 units were sold in Brighton between 6 a.m. and dusk, which demonstrates the enormous use made of electricity for motive power and basement lighting.

It may be of interest to those who are opposed to the maximum demand system to mention that only 7 per cent. of the consumers in Brighton last year failed to derive any reduction from the sliding scale, and a large part of this small percentage use the light so intermittently and irregularly as to make the regulation of pressure in their district very difficult; others are residents who use their houses in Brighton only for one or two months in the winter, and the occupiers of places of business and offices that close before 7 o'clock every evening.

For the purpose of showing how the demand system actually affects the accounts of consumers, we are reproducing two actual accounts

marked B and C. It will be noticed that B is apparently not a long hour consumer, for in the first half-year he is only able to consume 18 units at the lower rates, while C, not only in the first quarter derives striking advantage from the operation of the system, but in the second quarter the whole of the electricity consumed by him is charged at the lower rate. In other words he pays for the second quarter £1 13s. 5d. for 247 units, while B pays £1 12s. 9d. for 66 units. B's electricity bill for the year amounts to £10 16s. 11d., and the number of units consumed are 416, which averages 6·2d. per unit. On the other hand, C, who throughout the year is steadily obtaining his electricity at a cheap rate, pays annually £18 6s. 4d., and consumes 1,489 units at an average cost of 2·2d. It is not difficult to realise upon walking through the streets of Brighton that the paying consumers do not reside in the most fashionable quarters. Sometime ago we visited the poorer districts of the town, rarely if ever frequented by the visitors, and found electricity being used in the smallest shops. It was a revelation to find small sweet stuff, greengrocery establishments, butchers, beershops all consumers of electricity, while even marine store dealers and secondhand clothes shops were connected to the lighting mains. It is not because the profits at these establishments were large, probably the takings were not more than a few pounds per week, it is merely because the shopkeepers discovered that electricity was infinitely cheaper than gas. These are the long hour consumers, who obtain their electricity cheap and at the same time provide the most economical load for the electricity works.

B

Consumer's No. ..... Name ..... Address ..... Meter, Type No. & Size ..... Dem. Ind'r. No. & Size .....

Date.	Reading of Meter.	Units Chargeable	Reading of Dem. Ind'r.	Readings taken by.	Installation Notes.	Quarter's Charges.						Date Paid.
31-12-'95	251					Quarter ending 1st April, 1896.						
3-2	303	52	190			120 Units at 7d.	3	10	0			
2-3	341	38	170			,, at						
1-4	371	30	144			Meter Rent		2	6			
						Total				3	12	6
		120	168			Cr. Units at						
2-5	397	28				Quarter ending 1st July, 1896.						
3-6	419	22				48 Units at 7d.	1	8	0			
1-7	435	16				18 ,, at 1½d.		2	3			
						Meter Rent		2	6			
		66				Total				1	12	9
						Cr. Units at						
2-8	453	18				Quarter ending 1st October, 1896						
1-9	476	23				78 Units at 7d.	2	5	6			
1-10	513	37	150			,, at						
						Meter Rent		2	6			
		78				Total				2	8	0
						Cr. Units at						
3-11	558	45	150			Quarter ending 2nd January, 1897.						
1-12	608	50	175			92 Units at 7d.	2	13	8			
2-1-'97	665	57	145			60 ,, at 1½d.		7	6			
						Meter Rent		2	6			
		152	170			Total				3	3	8
						Cr. Units at						

C

Consumer's No. ..... Name ..... Address ..... Meter, Type No. & Size ..... Dem. Ind'r. No. & Size .....

Date.	Reading of Meter.	Units Chargeable	Reading of Dem. Ind'r.	Readings taken by.	Installation Notes.	Quarter's Charges.						Date Paid.
3-2-'96	977	171	185			Quarter ending 1st April, 1896.						
5-3	1119	142	175			178 Units at 7d.	5	3	10			
1-4	1228	109	175			244 ,, at 1½d.	1	10	6			
						Meter Rent		2	6			
						Total				6	16	10
		422	178			Cr. Units at						
1-5	330	102				Quarter ending 2nd July, 1896.						
2-6	407	77				247 Units at 1½d.	1	10	11			
2-7	475	68				,, at						
						Meter Rent		2	6			
		247				Total				1	13	5
						Cr. Units at						
4-8	556	81				Quarter ending 5th October, 1896.						
31-8	642	86				200 Units at 7d.	5	16	8			
5-10	777	135	200			102 ,, at 1½d.		12	9			
						Meter Rent		2	6			
		302	200			Total				6	11	11
						Cr. Units at						
4-11	931	154	200			Quarter ending 4th January, 1897.						
1-12	1077	146	195			519 Units at 1½d.	3	4	10			
4-1-'97	296	219	185			,, at						
						Meter Rent		2	6			
		519	193			Total	3	7	4			
						Cr. 7 Units at 5½d.		3	2	3	4	2

The advantages of supplying poor neighbourhoods with electricity are very marked from the suppliers' point of view, but it ought to be clearly recognised that very little can be done unless electricity is cheap; directly, however, the consumers in a poor neighbourhood have found electric lighting to be cheap they tell their neighbours, and thus advertise in the very best possible manner the merits of electricity. Probably one of the most serious obstacles in the way of developing the smaller class of consumers is the capital outlay involved in making the necessary connections to the mains, and there is no doubt that some method which is equally effective but less expensive than those usually employed is necessary in lighting poor districts.

At Brighton a simple system of jointing a house service has been evolved which is distinctly economical, and, we should imagine, highly efficacious. It consists of a lead T joint cover in two halves, and after the house service has been connected to the main the top half of the cover is fitted on to a ledge in the lower half in such a way as to permit of molten metal being run in, which effectually seals the two halves together, moreover, the cover is in complete connection with the armouring of the cable. Electricity at Brighton is charged on one tariff, whether for street lamps, corporation buildings, or private consumers, no discount whatever being given to large consumers. Before leaving the subject of charging, it is interesting to give the following statement of the average prices paid for the electric lighting of the various municipal buildings, which show the benefit the Corporation derive from this equitable scale of charges which automatically discriminates between the profitable and unprofitable irregular users: —

	Average price paid.
The Dome	7d. per unit.
Pavilion Rooms	5⅝d. ,,
Technical School	5¼d. ,,
School of Art	4⅝d. ,,
Town Hall	2½d. ,,
Public street lighting	2d. ,,

Babcock & Wilcox Boilers at Brighton.

The case of the Dome well illustrates the justness of the system. When the Pavilion Committee generated their own electricity the average cost per unit came to over 2s., and it costs this undertaking just as much to provide the necessary machinery and mains for supplying the Dome, which is used less than twice a week on the average, as if it were used every night.

The table which we reproduce showing the growth of the electricity works is interesting, and, moreover, reveals some curious results, that may be justly attributed to the special system of charging. In conjunction with this the curve showing the units sold per maximum kilowatt demanded off mains is instructive, because it demonstrates very clearly how the units sold per maximum kilowatt follow the lowering of the secondary tariff. It will be seen that in less than seven years the number of consumers has increased 10 times, the lamp connection increasing at about the same rate. The total revenue has grown very markedly, and nothing shows the advantages of the system of charges more than a comparison between the total revenue per annum and the average price obtained per unit.

In the administration and management of the Brighton works there are many features interesting to central station men, and probably at a future date we may refer to them.

Electric Traction Patents in Italy.—An action has been brought by La Compagnie Thomson-Houston de la Mediterranée against the Leghorn Electric Tramway Company for alleged infringement of its patents. The case has been adjourned in order that Messrs. Schuckert & Co., of Nurembourg, who supplied the plant, may reply to the charges.

Table Showing Progress at Brighton.

	1892.	1893.	1894.	1895.	1896.	1897.	1898.	To date. March 6th, 1899.
Number of units sold	156,110	286,895	583,701	867,494	1,388,821	1,992,501	2,648,701	...
Total number of consumers connected	213	423	853	1,065	1,366	1,723	2,062	2,104
Total number of lamps connected	11,229	17,760	38,249	50,064	66,720	86,299	108,547	111,479
Number of units sold per maximum load on station	603	700	788	946	1,068	1,130	1,114	...
Maximum demand off mains in kilowatts (selling load)	223	368	654	826	1,152	1,495	1,962	...
Units sold per maximum kilowatt demanded off mains	700	780	890	1,050	1,210	1,340	1,353	...
Number of 8-C.P. lamps connected per 1,000 inhabitants	96	151	322	419	553	708	887	...
Number of units sold per inhabitant	1·3	2 4	4 9	7 3	11·5	16·3	21·6	...
Increase in number of units sold	...	130,785 83 %	296,806 103%	283,793 49 %	521,327 60%	603,680 43 %	656,200 33%	...
Average price obtained	7d.	6 18d.	6·12d.	4 71d.	4 46d.	3 35d.	3·32d.	...
Total revenue	£4,687	£7,806	£15,556	£17,550	£26,527	£28,828	£37,831	...
Gross profit...	£2,229	£4,157	£9,384	£9,012	£14,714	£14,205	£19,289	...
Net profit	£8	£446	£4,870	£1,235	£5,883	£2,969	£6,891	...

Statement Showing how the Profit Made in Brighton During 1898 was Derived.

	£	s.	d.	£	s.	d.
Net cost of getting ready to supply electricity, including salaries, wages, interest, and sinking fund, repairs to mains, &c.	23,349	0	0			
Cost of producing the electricity consumed during the first hour per day, including coal, stores, and plant repairs. 877,460 units at ⅜d. per unit	2,192	0	0			
				25,541	0	0
Cost of producing all electricity consumed after the first hour's daily use. 1,771,241 units at ⅜d. per unit				4,429	0	0
				£29,970	0	0

	£	s.	d.
Revenue derived from sale of electricity during the first hour per day, 877,460 units at 7d. per unit ...	25,592	0	0
Revenue derived from electricity after first hour's daily use, 1,771,241 units at 1½d. per unit	11,070	0	0
Surplus on work done on consumers' premises	199	0	0
	£36,861	0	0

Balance.

	£	s.	d.	£	s.	d.
Profit on units sold during the first hour per day ...	£51	0	0			
Profit on units sold after first hour per day at $\frac{1}{10}$d. per unit	6,641	0	0			
Profit on work done on consumers' premises	199	0	0			
				£6,891	0	0
				£36,861	0	0

	£	s.	d.
	£36,861	0	0

ELECTRIC LIGHTING NOTES.

(*Continued from page* 552.)

St. Pancras.—The Vestry at the last meeting sanctioned an expenditure of £3,583 for the purpose of extending the arc lighting in Gordon Square and other thoroughfares by the erection of 49 arc lamps, and decided at the same time to lay low tension mains in part of the same area at an estimated cost of £650. The Electricity Committee reported that additional plant was required to meet the future demands upon the Regent's Park station. It appeared that the two large engines and dynamos ordered in November, 1897, had not yet been delivered, and Mr. S. Baynes, the chief electrical engineer, did not expect to obtain delivery of the first set until August, and the second set in September next. The committee stated that when erected that plant would only be sufficient to meet the increased demand for the next two years and that it was advisable, owing to the long period of delivery due to the activity in the engineering trade, to obtain tenders for additional plant, the supply of which could not be expected for quite two years. On the recommendation of the committee it was resolved to invite tenders for two 750-H.P. engines and dynamos with condensing plant and pumps and two boilers fixed complete at a total cost of £19,000.

Stratton.—The District Council last week had the electric light question under consideration. The terms upon which the Bude Electric Lighting Company could supply current were stated by Mr. Gurney. The Council, after discussion, decided to recommend the Parish Council to adopt electric lighting as soon as the company can supply it.

Sunderland.—The Lighting Committee has had before it a report from Mr. Snell, the electrical engineer, regarding applications for current in Monkwearmouth; the cost of acceding to the applications would be £577, and the income from consumers would be £90 per annum. After consideration it was thought that the importance of introducing the light into the lower districts of Monkwearmouth was so great as to justify an adjournment for further consideration. Upon Mr. Snell's recommendation the Committee decided upon a new departure in the erection of three pillar boxes in different sections of the town, so that in case of anything going wrong with the light the fault could be located from one of the pillar boxes, and the light turned off from one district without disturbing the others.

Weston-super-Mare.—On 28th ult. Major Cardew held an inquiry into applications of the Weston-super-Mare and District Electric Lighting and Power Syndicate and the Municipal Electric Power and Distribution Company for provisional orders. Mr. Sydney Morse was in attendance for the Municipal Electric Power and Distribution Company, to whom the Council are seeking to transfer their powers. Mr. F. E. Gripper, electrical engineer to the syndicate and managing director of Edmundsons' Electricity Corporation, appeared for the syndicate. Arguments were put forward in favour of both applications, and Mr. W. C. C. Hawtayne, who was engaged by the Council, compared the terms of the contending companies, giving, as his opinion, that the terms of the Municipal Company were preferable. Major Cardew said he would report to the Board of Trade at an early date.

Woking.—Last week a public meeting discussed the electric lighting question, and decided to request that the District Council at once convene a special meeting of ratepayers to take into serious consideration the advisability of negotiating for the purchase of the company's undertaking.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Aberdeen.—The Tramways Committee last week had under consideration the contracts for the construction of the electric tramways between Market Street and Woodside. The work was divided into five sections, as follows:—Permanent way and road work, overhead line construction; feeder, pilot, and test cases; cars and accessories, and switchboards and instruments. For the first section, the offer of Messrs. John M'Adam & Sons, Aberdeen, was accepted, at a cost of about £19,000. For the remaining sections, the following leet of four firms was selected:—Blackwell & Co., British Thomson-Houston Company, M'Cartney, M'Elroy & Co., and the Westinghouse Company. In connection with these, it was remitted to a sub-committee consisting of the convener, Treasurer Bisset, Mr. Glass, and Mr. Bell, the electrical engineer, to make inquiries with regard to certain points in their tenders, when one or other of these firms will be selected for the contracts mentioned.

Blackburn.—The electric cars have been very successful during the few days they have been running. Last week 44,000 more passengers were carried than in the same week last year, while the receipts were nearly £450 more.

Chester-Kelsall.—A meeting of Kelsall residents was held some days ago to consider a proposed light electric railway between the above two places. The length is put at eight miles, and the cost about £40,000. Mr. Rowlands, of London, who is one of the promoters of the undertaking, gave a few details of the proposal. He asked the meeting to pledge itself to a certain sum toward the promotion expenses. The application ought to be lodged at once with the Light Railways Commissioners. A committee was formed to further consider and arrange for the scheme to be proceeded with.

Dover.—At last week's meeting of the Corporation it was stated that the result of the year's working of the municipal electric tramways was a sum of £9,000, taken in 1d. fares. A profit of over £2,000 has been made, which goes towards the relief of the rates.

Glasgow.—The Corporation Tramways Committee last week considered offers for the conversion of several routes of the tramway system to electric traction. The Committee recommended the acceptance of offers amounting to £102,000, and these contracts, if fixed, will connect the south side and east end of the city with Kelvingrove Park, where the Exhibition of 1901 is to be held. The successful contractors are as follows:—Messrs. A. Stark & Son, Glasgow, from Whiteinch to Anderston Cross, £25,739; Messrs. A. & J. Faill, Glasgow, from Langside, *viâ* Eglinton Street, Renfield Street, and Sauchiehall Street, to Overnewton, £32,610; Messrs. M'Cartney, M'Elroy & Co., America, from Anderston Cross to Bridgeton Cross, and also London Road to terminus, £20,754; and Mr. Daniel Murray, Maryhill, from Bridgeton Cross to Dalmarnock terminus, Pollokshaws and Pollokshields to Eglinton Toll, and Rutherglen Road, from Brachead Street to Crown Street, £22,973. Mr. H. F. Parshall, London, was appointed consulting engineer.

Keighley.—The Corporation Gas Committee is trying to get the Keighley Tramways Company to agree to take a supply of electricity for working the tramways. The decision turns on the question of charge. In the event of a change, the Corporation may either furnish the new cars and rent them to the company, or the company may provide cars of their own, to be taken over by the Corporation at a valuation when the company's lease runs out. The question of buying out the company has been referred to, but at present appears to be out of the question. The Corporation distributing centre is to be at Low Bridge.

Liverpool.—It is stated that on Sunday an accident occurred to an electric car and trailer. When turning a corner into Canning Place both left the rails, and a cab was somewhat injured by collision. A newspaper report says that the car driver applied the brake when nearing the corner, but it failed to act.

Morecambe-Fleetwood.—Plans have been submitted to the Lancaster District Council of the route proposed for the Morecambe-Fleetwood Electric Tram Company's line. They have been referred to the Highways Committee.

Sunderland.—With reference to the Corporation's Bill for working tramways by electricity, that body last week came to terms with the Sunderland Tramways Company to take over as a going concern in January next the existing horse tramway. The purchase money is to be £34,000.

West Ham.—The Town Council last week had a discussion on the tramways question, the Tramways Committee having suggested that a deputation should visit Glasgow, Dover, Halifax and Dublin for the purpose of seeing electric tramways there. A recommendation was taken back by the committee for further consideration.

TELEGRAPH AND TELEPHONE NOTES.

German Cable Station in Africa.—The Bureau International of Telegraphs in Berne announces that in the course of the present month it is proposed to put into telegraphic communication the district known as Swakopmund, a place on the South-West Coast of Africa, in the neighbourhood of Wilfiech Bay. This will be done by leading in the cable, the property of the Eastern and South African Telegraph Company, which at present runs direct from Cape Town to Mossamedes.

Glasgow and the Underground Telephone Pipes.—The dispute between the Corporation of Glasgow, as the local authority in charge of the streets, and the Postmaster-General regarding the demand of the Post Office authorities to lay pipes underground for the purpose of affording facilities to the National Telephone Company for the connection of local exchanges, is about to come to a head. The Glasgow papers say that Sheriff Berry has fixed Wednesday, April 19th, at 11.30 a.m., as a date on which to hear parties in the petition by the Post Office for the granting of the consent sought for. The pursuer is the Right Hon. A. Graham Murray, Lord Advocate, acting under the Crown Suits (Scotland) Act, 1857, on behalf of and as representing the Postmaster-General.

Hull Telephones.—The Works' Committee of the Corporation has granted the National Telephone Company permission to place their wires underground on certain conditions.

The Postal Telegraphists.—At a meeting convened by the Postal Telegraph Clerks' Association last week, Mr. C. H. Garland (general secretary of the London Branch of the Association), moved a resolution which reiterated the demand for a Select Committee of the House of Commons to inquire into the causes of dissatisfaction in the Postal Telegraph Service. He said that the £380,000 additional which had lately been appropriated to an increase in salaries, simply meant in many cases an additional 4½d. per week to men not having enough to live upon. They claimed that every man in the Postal Telegraph Service should be able to rise to £190 per annum as an operator. They asked for an impartial inquiry, despite what Mr Hanbury had said. The resolution was adopted.

A Protest against Monopoly.—At Calcutta during the discussion of the Indian Budget in the Legislative Council, Mr. Allan Arthur, the representative of the Calcutta Chamber of Commerce, referred to a long standing grievance, namely, the cost of telegrams between India and Europe. He said that the cable companies were the enemies of progress in this matter, and pointed out how badly India was served with Press messages, and how high charges were strangling Press enterprise, with the result that this great Empire was kept most meagrely informed of what was going on in other countries of the world. He held in his hand telegrams from every Chamber of Commerce in India pressing the Bengal Chamber to urge the importance of this question on the notice of the Viceroy. The merchants of India respectfully asked that this measure of Imperial importance be carried out, and he assured the Viceroy that any action which the Government might take to effect the desired reform would have the unanimous and ardent support of the entire mercantile community of India.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Amazon Company's cable—		
Cable beyond Gurupa ...	June 11th, 1898 ...	...
French Company's cables—		
Paramaribo-Cayenne ...	Feb 10th, 1899 ...	...
Cayenne-Pinheiro ...	March 10th, 1899 ...	...
Landlines.		
Communication between Mossamedes and all Inland Offices.	March 16th, 1899 ...	...
Direct communication between Rome and Pera.	March 25th, 1899 ...	March 30th, 1899.
Communication between Salonique and Monastir.	March 23rd, 1899 ...	...
Communication with Campeche, Progreso, and Merida in Mexico.	March 31st, 1999 ...	April 5th, 1899.
Lines of Western Australia...	March 23rd, 1899 ...	March 29th, 1899.

The Telephone Bill.—The Parliamentary Committee of the Liverpool Corporation, having fully considered the subject, is of the unanimous opinion that Mr. Hanbury's scheme is unsatisfactory, and they recommend the Council to oppose it on the grounds that it is proposed to spend Imperial funds in establishing a Government telephone system in London in competition with the National Telephone Company, without making any corresponding provision for the establishment of a Government telephone system in the large provincial towns, where the National Telephone Company have practically a monopoly; that subscribers to the Government system in London are to get all the benefit of Imperial expenditure and to be free from the 10 per cent. royalty which the subscribers in the provinces have to pay; that the proposal to allow a municipality to compete until 1911 with the National Telephone Company, where the company is well established in the town, can only end in a loss to the rates and inconvenience to the public in carrying on the competition; and that if competition is to be carried out it should be by the Government. The Committee recommended that the Council co-operate with the Chamber of Commerce in asking the members of Parliament to oppose the present scheme and to advocate the principle of the Government nationalising the telephone system.

It is stated that on Wednesday a deputation representing large municipal bodies in Scotland met the Right Hon. R. W. Hanbury, M.P., at Preston with reference to the question of telephone municipalisation. The deputation came from Aberdeen, Glasgow, and Paisley. The business was strictly confidential.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—April 23rd. Tenders are being invited until the 23rd inst. by the municipal authorities of Brunn for the supply of four Edison dynamos (model K) of 200 amperes and 110 volts capacity, one small and two large Gramme dynamos for arc lighting, three boilers of the Dufuis type to work at a pressure of 105 lbs. and one 100-H.P. steam engine with Colmann valve gear. Tenders to be sent to Der Magistrat, Brunn, whence particulars may be obtained.

Belfast.—April 20th. The Electric Committee want tenders for mechanical stokers, economisers, pipe work and condensing plant. See our "Official Notices" March 31st.

Bradford.—April 12th. The Corporation want tenders for a complete battery and switchboard for the electric light station. See "Official Notices" March 31st.

Bristol.—April 10th. The Electrical Committee want tenders for high tension switchboards, instruments, &c. See "Official Notices" March 31st.

Dudley.—April 14th. Tenders are invited for the construction of about 2½ miles of tramway permanent way from Dudley to Cradley Heath, Staffordshire, for the British Electric Traction Company, Limited. Particulars from the company's permanent way engineer, Mr. W. Howard-Smith, A.M.I.C.E., Donington House, Norfolk Street, Strand, London, W.C., on payment of £2 2s., to be refunded upon return of documents.

Edinburgh.—April 10th. The Corporation wants tenders for the electric lighting of the City Chambers. See "Official Notices" March 24th.

Epsom.—May 8th. The District Council wants tenders for various plant for its electricity undertaking, including boilers, dynamos, boosters, batteries, switchboard, crane, mains and road-work, arc and incandescent lamps, and for the lighting of the station. See our "Official Notices" this week.

Hampstead.—May 18th. For the purpose of extensions at the electricity works, the Vestry wants tenders for two 500-kw. steam alternators, five switchboard panels, boilers, feed water heaters, Weir's feed pumps, a 50-kw. exciter, water softening plant, air pump and condenser, Green's economiser and overhead crane. See "Official Notices" this week.

Kingston-upon-Hull.—April 25th. The School Board wants tenders for an electric light installation for the Central Higher Grade School, and School of Science in Brunswick Avenue, Beverley Road. Particulars from Mr. O'Donoghue, clerk, School Board Offices, Albion Street, Hull.

Leeds.—April 8th. Tenders for the electric lighting of the new dead meat market and abbatoir now erecting in New York Street are to be lodged with the acting town clerk (Mr. C. C. Jolliffe) by the above date. Particulars, plans, &c., from Messrs. W. Hanstock and Son, architects, Branch Road, Batley.

Peterborough.—April 20th. The Corporation wants tenders for Lancashire boiler, steam dynamos, balancers and boosters, switchboard, battery, piping, cables, &c.

Poplar.—April 25th. The Board of Works wants tenders for engine and boiler house plant, battery equipment and street lighting. See "Official Notices" March 17th.

Reigate.—May 1st. The Town Council wants tenders for water-tube boilers, pipe work, two 100-kw. and one 30-kw. steam alternators, overhead crane, sub-station equipment, switchboard, mains, lamp-posts, &c. See our "Official Notices" this week.

Rochdale.—April 12th. The Guardians want tenders for an electric light installation at the Workhouse buildings and cottage homes. See our "Official Notices" March 24th.

St. Helens (Lancs.).—April 19th. Tenders are wanted for the construction of about six miles of tramways in sections, for the Electric Supply and Tramways Committee. Plans and form of tender on application to Mr. Geo. J. C. Broom, M.I.C.E., borough engineer, on payment of £2 2s., returnable as usual.

Spain.—April 20th. The municipal authorities of Santiago are inviting tenders for the supply and erection of the plant for a central power station to be erected near the town to utilise the water-power of the River Tambre for the generation of electrical energy for lighting and power purposes. Particulars may be obtained from, and tenders are to be sent to, El Presidenté del Consejo de Administracion Santiago, Spain.

Stockport.—April 19th. The Gas and Electricity Committee wants tenders for an electric storage battery of 130 cells, having a capacity of 750 ampere-hours. See our "Official Notices" this week.

Sutton and Howth (Ireland).—April 20th. The Great Northern Railway Company wants tenders for works in connection with their line between Sutton and Howth, near Dublin, including the supply and laying of feeders, returns, &c., rolling stock, overhead construction, battery and booster, &c. See our "Official Notices" March 24th.

West Ham.—April 21st. The Council want tenders for two 1,500-I.H.P. engines, and two 800-kw. alternators and exciters, or two 800-kw. 1,500-I.H.P. steam alternators and exciters. See our "Official Notices" March 31st.

West Hartlepool.—April 15th. The Corporation invites offers from those prepared to undertake free wiring of premises. See our "Official Notices" March 31st.

CLOSED.

Gillingham.—The tender of Messrs. Priestley & Taylor, of Leeds, has been accepted for the electric wiring and fitting of the Technical Institute (£107 17s.).

Shoreditch.—The Vestry at the meeting on Tuesday accepted the following tenders for the annual contracts for the Electric Lighting Department:—

Williamson & Joseph—Supply of switches, ceiling roses, and cut-outs.
The Edison & Swan Electric Company—Incandescent lamps and arc globes.
G. Braulik—Shades, flexible wires, and insulating materials.
Thos. Tilley & Sons—Street lamps, cradles, and gas fittings.
The General Electric Company—Supply of rubber tapes.
Johnson & Phillips—Supply of fuse and lead wires.
Crompton & Co.—Supply of carbons.
Pryke & Palmer—Supply of ironmongery and tools.

The Vestry also considered the undermentioned tenders for the supply and erection of a new battery switch panel at the electric light station:—

Crompton & Co.	£185 0
Nalder Bros. & Thompson	197 10
General Electric Company	225 0
Veritys	240 0
Electric Construction Company	295 0

It was decided on the recommendation of the Lighting Committee, acting upon the advice of the consulting engineer, to accept the tender of Messrs. Nalder Bros. & Thompson.

FORTHCOMING EVENTS.

Monday, April 10th.—At 7 30 p.m. Society of Engineers, Royal United Service Institution, Whitehall. Paper on "Machine Tools," by Mr. Ewart C. Amos, M.Inst.M.E.

Tuesday, April 11th.—At 8 p.m. The Institution of Civil Engineers. Paper to be further discussed:—"Alloys of Iron and Nickel," by Robert Abbott Hadfield, M.Inst.C.E.

Wednesday, April 12th.—At 8 p.m. Society of Arts. "Telephones," by John Gavey, assistant engineer-in-chief and electrician to the General Post Office. William H. Preece, C.B., F.R.S., will preside.

Thursday, April 13th.—At 8 p.m. Institution of Electrical Engineers. "The Hissing of the Electric Arc," by Mrs. Ayrton (conclusion of discussion). "Experiments on Alternate Current Arcs by Aid of Oscillographs," by W. Duddell and E. W. Marchant, associates. (The discussion on this paper, which was published in Part No. 138 of the *Journal*, to be opened by the authors with an exhibition of experiments.)

Friday, April 14th —At 9 p.m. Royal Institution. "Earth Currents and Electric Traction," by Prof. A. W. Rücker.

Thursday, April 20th.—At 8 p.m. Institution of Civil Engineers. The seventh "James Forrest" lecture, by Prof. J. A. Ewing, subject "Magnetism." Lecture to be repeated on Friday, 21st inst., at 4 o'clock.

Friday, April 21st.—At 5 p.m. Physical Society. Agenda:—1. "On the Effect of a Solid Conducting Sphere in a Variable Magnetic Field on the Magnetic Induction at a Point Outside." By Mr. C. S. Whitehead, M.A. 2. "Demonstration of Richards's Method of Standardising Thermometers." By Mr. R. A. Lehfeldt, D.Sc.

NOTES.

Glasgow Technical College Scientific Society.—At a meeting of the above Society held on 25th ult., a paper was read by Mr. Frank B. Lea, B.A., A.M.I.E.E. (of the British Electric Traction Company), on "Electric Traction in Ordinary Railway Working." Mr. Lea dealt in a most interesting manner with the problems to be met in such work, and described the applications of electric traction on railways in Britain and America, together with interesting comparisons of the steam and electric locomotives in use. After a long and interesting discussion, Mr. Lea was awarded a hearty vote of thanks for his paper.

Wire Rope Preservation.—The *Street Railway Journal* describes a form of wire rope filler for filling the interstitial spaces of ropes. In a stranded rope of six strands with a central core there is a good deal of space for the filling, which it is claimed will exude and prevent injury from acids or water. The question is, How long such a filling will retain preservative virtues, and if it is suitable for ropes of small size, such as span wires? There are thousands of miles of small span wire exposed to every vicissitude of climate and smoke, and the efficacy of galvanising is more or less doubtful. Zinc does not give an adherent flexible coating on a wire of iron or steel, and we know of nothing that does. A durable preservative is wanted which will not demand constant attention.

The Advance of Science!—The *Westminster Gazette* says it is suggested in one of the daily papers that possibly the heavy catalogue of disasters on Saturday may be due to the powerful currents of electricity thrown across the Channel in the process of wireless telegraphy. The idea is that these may have interfered with the needle in the compass, and so contributed to throw the most careful navigators out of their course without their either knowing it or being responsible for it.

An Electric Wave Detector.—Neugschwender describes in the February number of *Wiedemann's Annalen*, p. 430, a simple device for detecting electric waves which is of considerable theoretical interest. If a scratch is made in the silver coating of a mirror so as to divide the coating into two parts insulated from one another, then no current will pass when the two parts are connected to the terminals of a Daniell cell. If the gap is breathed upon, moisture is deposited and a deflection of the galvanometer takes place. When electric waves are generated in the neighbourhood, the galvanometer (if of medium sensitiveness) flies back to zero, showing that the impact of the waves has made the resistance of the gap very great. Breathed upon again, the gap becomes again a conductor and the galvanometer again shows a deflection; if the previous deposit of moisture has been considerable, the conductivity may restore itself automatically. If a damp cloth is laid over the gap, the galvanometer returns to zero only at the moment of impact of the electric waves. The gap was too wide (0·3 mm.) to permit the ordinary metallic coherer effect, *i.e.*, no reduction of resistance was caused by electric waves in the absence of the moisture. When the silver layer was replaced by copper and zinc the same effect was observed, but platinum appeared not to act. The glass was replaced by several other good insulators which all acted the same as the glass. Instead of water vapour ammonia and solutions of salts were used with equal success. The experiment succeeded even when the liquid was not visible to the eye. Mechanical vibrations or sound waves did not affect the conductivity of the gap. Heat or static electricity have no influence on the conductivity, but even small sparks have a marked effect. The recuperative action is so rapid that when a telephone is introduced into the circuit, the note of a rapid break on the wave generating coil is reproduced.

Another French Electric Locomotive.—If the description in the *Scientific American* be correct we cannot say much for the new electric locomotives of the Paris-Lyons Railway. Each loco is mounted on three pairs of 3·6 feet wheels, the rear pair being drivers and each axle carrying continuous current motors with Brown type armatures with enclosed conductors of elliptic copper bars, 150 in number. There are said to be 18 accumulator elements for slow speeds and an additional 192 for high speeds are carried in a tender car. They have a capacity of 1,000 ampere-hours and the whole concern with its tender weighs 198,660 lbs. This hauled a maximum load of 147 tons at 27 miles per hour between Paris and Melum, and a speed of 60 miles was obtained with 100 tons, while it is estimated that this speed may be greatly exceeded without inconvenience. The French seem to be quite on the wrong tack in their experiments with electrical traction, and we cannot think that they are likely to do much good with accumulators on heavy service. The weight of the locomotive alone is sufficiently formidable to prove that so far they cannot be on the road to success. An engine of nearly 100 short tons and a train of only 147 tons at 27 miles per hour, do not appeal to one's idea of railway service conditions.

Lectures.—On March 30th Mr. C. J. Hall read a paper on "Electricity" before the Leeds Association of Engineers. After referring to the advantages of the high pressure single-phase alternating current and the flexibility of that system, he proceeded to explain the still greater advantages of the multiphase system for lighting and traction work. A discussion followed the paper.

At the Torquay Natural History Society on 27th ult., Mr. T. Vicars, F.G.S., lectured on "Wireless Telegraphy."

Electric Cabs in Paris.—It is stated by Dalziel that from 60 to 70 new electric cabs of the landau type were put on the Paris streets on Sunday, and were well patronised by the public. About 100 more will be shortly brought into use.

Society of Arts.—In the calendar of meetings arranged for April and May, 1899, are the following:—April 12th, 8 p.m. Mr. John Gavey, "Telephones." May 3rd, 8 p.m. Mr. William H. Preece, C.B., F.R.S., "Aerial Telegraphy."

Wireless Telegraphy.—Some 12 months ago we described in detail the results of Mr. Marconi's experiments in sending perfectly readable signals between Bournemouth and the Isle of Wight. Since then Mr. Marconi has made marked progress in the practical application of his system of wireless telegraphy, and has in fact within the last few days successfully transmitted messages between South Foreland and Boulogne. Naturally this achievement has excited the widest attention, and probably there is no subject at the present moment in which the public is more intensely interested. The publication of the results of the Boulogne experiments has provoked the usual criticisms, but we regret to find so eminent a scientific man as Mr. Nikola Tesla reiterating the already exploded statement that Mr. Marconi has done nothing new. It is distinctly unfair to a young and able inventor who has never sought to withhold credit from workers in the same branch of science and who has been always ready to admit that his practical achievements have been based on the theoretical work of Hertz and others. We are quite in accord with the following remarks made by Prof. Fleming in a letter to the *Times* on the subject of Marconi's work.

I cannot help thinking that the time has arrived for a little more generous appreciation by his scientific contemporaries of the fact that Signor Marconi has by minute attention to detail, and by the important addition of the long vertical air wire, translated one method of space telegraphy out of the region of uncertain delicate laboratory experiments and placed it on the same footing as regards certainty of action and ease of manipulation, so far as present results show, as any of the other methods of electric communication employing a continuous wire between the two places. This is no small achievement. The apparatus, moreover, is ridiculously simple and not costly. With the exception of the flagstaff and 150 feet of vertical wire at each end, he can place on a small kitchen table the appliances, costing not more than £100 in all, for communicating across 30 or even 100 miles of channel. With the same simple means he has placed a lightship on the Goodwins in instant communication, day and night, with the South Foreland lighthouse. A touch on a key on board the lightship suffices to ring an electric bell in the room at South Foreland, 12 miles away, with the same ease and certainty with which one can summon the servant to one's bed room at an hotel. An attendant now sleeps hard by the instruments at South Foreland. If at any moment he is awakened by the bell rung from the lightship he is able to ring up in return the Ramsgate lifeboat, and, if need be, direct it to the spot where its services are required, within a few seconds of the arrival of the call for help. In the presence of the enormous practical importance of this feat alone, and of the certainty with which communication can now be established between ship and shore without costly cable or wire, the scientific criticisms which have been launched by other inventors against Signor Marconi's methods have failed altogether in their appreciation of the practical significance of the results he has brought about.

The following represents the type of criticism of wireless telegraphy which one meets in the daily press :—

WIRELESS TELEGRAPHY.

To the Editor of "The Standard."

Sir,—This is hardly a new invention. Dr. O'Shaughnessy, Director and Superintendent of Telegraphs in India, sent messages across the River Sone, in Bengal, in 1856-57, without use of wires or cables.

I am, Sir, your obedient servant,
Geo. Benson.

1, St. John's Gardens, Wiltshire Road, Brixton, S.W.,
April 4.

This is hardly a new story. To electrical men it is a chestnut, yet letters of this kind are published *ad nauseam*.

The Deputy Master of the Trinity House, with a committee of Elder Brethren, accompanied by Lord Rayleigh, their scientific adviser, and Captain the Hon. F. C. P. Vereker, of the Board of Trade, left London on Wednesday for Dover, with the object of making an official inspection of the wireless telegraphy system as experimentally in operation between the South Foreland lighthouse and the East Goodwin light vessel. Mr. Marconi and other gentlemen interested in the scheme met the committee at Dover.

It is stated that the French authorities are so pleased with the success of the wireless telegraph system from Boulogne to the South Foreland, that an attempt is to be made to send messages from the latter place to the Eiffel Tower, at Paris, a distance of 230 miles.

Presentation.—Mr. Bishop who is leaving the Folkestone Electricity Supply Works, was some days ago made the recipient of a fitted leather dressing and writing case, presented by the staff as a mark of appreciation.

The Metallurgical Industries of France.—M. Adolphe Minet, in a recent issue of the *Bulletin Technique*, gives a very optimistic forecast of the future of these industries in France, with the aid of her great resources of natural power in the form of waterfalls and of the modern electrical methods of their development and utilisation. France has plenty of the raw materials of these industries; but hitherto, owing to the lack of coal near to the mineral deposits, these have remained practically unutilised. The aggregate value of the minerals and metals produced is greatly below that of those produced in Germany, England, and the United States. According to Minet, coal is imported to the value of £4,000,000 annually, while the production of lead is only 10 per cent., of zinc only 25 per cent., and of copper only 5 per cent. the consumption. No tin is extracted from its ores in France. The utilisation of water-power is expected in time to change this position; and as pointed out in our article on the St. Michel chlorate works (see Electrical Review, November 25th, 1898), the Haute Savoie district of South-Eastern France has already become of considerable industrial importance.

Compulsory Boiler Inspection.—We are glad to see Mr. Michael Longridge again objecting to the proposal to saddle steam users with Board of Trade inspection. In 12 months the Board of Trade reports 84 explosions. Of these only 38 occurred on land, and therefore 46 occurred at sea and to boilers under the care of Board of Trade inspectors, who are to be set to supervise land boilers. The Board of Trade inspectors may well be asked first to set in order their own house, and meanwhile leave land boilers to the care of Mr. Longridge and his competitors. Mr. Longridge further points out that of the land explosions there were 16 which did not merit the name, being merely small fractures of pipes and in no sense explosions, though they are included by the Board of Trade officials in their anxiety to get a grip of land boilers. In one case, some years ago, it is said that the melting of a fusible plug was ranked as an explosion. He also very correctly points out that the Barking explosion would not have been prevented by inspection. It was due to over-pressure, and most probably arose from neglect of the man who should have seen to the gauge and safety valve after the hydrostatic pressure had been applied.

An Electric Lounge Experience.—A recent issue of the New York *Electrical Engineer* contained an article on "The Illegitimate Watt," in which the author, Mr. J. L. Morgan, quotes a very amusing experience as follows :—

As city electrician I received a telephone call from a doctor in one of the large office buildings to come and inspect an "electric lounge." I had never heard of an electric lounge, but putting on a bold front and a look of infinite wisdom, I knocked at the office door. I was admitted by the doctor, and he "looked the part." Tall, melancholic, and dressed in sombre black, he looked the typical wizard; and although his long Prince Albert coat, *negligé* shirt, and lay-down collar were a bit odd, his horn spectacles and curly wig gave him a look that was not soon to be forgotton. After showing me the mechanism of the lounge, which consisted of 32 electro-magnets underneath the surface, he explained that with the double-throw switch he could get a steady stream of magnetic lines through your system, much like you would squirt water on a chained dog, or with the other throw of the switch you get the short-arm jab effect derived from the alternating current. All that he wanted was a certificate stating that it was a good and safe institution to patronise, which no doubt it was, as he told me that he had reclined all morning on the lounge, and that the effect was marvellous. Upon closer examination I saw that one of the wires was disconnected. The wily contractor had simply wound the magnets with any old scrap wire he happened to have and then left the circuit open, knowing that the machine was as potent without the current as with it. An employé of the firm that made the machine was present, and at my suggestion he reluctantly closed the circuit and threw the switch on the "short-arm jab" side of the switch for a trial trip. And the effect was marvellous. The 32 magnets vapourised like shots from a rapid-fire six-pounder, the excelsior stuffing took fire, and to all this the doctor danced wildly and howled, "Turn her off!" "Turn her off!" The device was getting its current from a keyed socket on the chandelier, and although it was working grandly, I turned the key, but the current was too heavy to be broken by such a small "break," so we had pyrotechnics at two places. When the current was finally turned off and the room cleared of the dense white smoke from the excelsior and the sickening fumes from the burnt shellac and varnish, an inventory showed one electric lounge in a wreck, a chandelier in the same condition, a tremendous heap of law books in the area way, where they had been thrown by an excited tenant, two music teachers and a voice culturist in a swoon, and a very mad and disgusted doctor.

Smokeless Firing.—The *Gas World* states that before the German Commission on Smokeless Firing, Herr Meyer, manager at Malsatt, said recently that the experiments which had been made during the past two years upon burning coal dust had given results favourable in every way. It is possible with every variety of coal, whether it gives a long or a short flame, or whether it binds or not, to burn the fuel, with a regulated consumption of air, in such a way that there is no smoke in the chimney. The difficulties lie not so much in the burning of the fuel as in the preliminary drying of it. In Müller and Pfeiffer's drum it is possible to deal even with coal slime containing 25 to 30 per cent. of water, drying it so completely that there is no appreciable loss in the heating value; and the coal is thereafter most easily reduced to powder. Several forms of grinding apparatus have been tested during the past three years; but the grinding presents no difficulty when once the material is properly dried, though the grinding mills differ in their consumption of power and the amount of oversight they require. In Schwartzkoff's apparatus the combustion is very simple. It is necessary to watch that there is no smoke; but there is no smoke even when the oxygen is all used up and there is 5 per cent. of carbonic oxide in the products of combustion. Tests have been made in order to see whether there was any danger of explosion or loss of heating power through the grinding, and there seems to be none. Contrary to what might have been expected, even a lighted candle will not set fire to a cloud of dry coal dust. It appears, curiously enough, that there must be carbonic oxide mixed with the air before any such explosive or kindling effect can be produced. It is to be regretted, therefore, that the German railways have set their faces against the handling of ground coal.

The Société Internationale des Electriciens.—The meeting of January, 1899, was devoted to a general study of electrical apparatus in France. M. Hillairet presided. M. Brunswick suggested in a short speech that it would be desirable for constructors of electrical apparatus to come to an understanding with regard to mechanical as well as electrical conditions, adopting, for instance, the uniform screw-thread prescribed by the Société d'Encouragement. M. Vedovelli then described various apparatus that he had brought to the meeting. First he said that the best contacts were obtained with yellow copper. He then submitted a multiple direction commutator for 1,500 amperes. He had found that it was preferable to make slow breaks rather than sudden ones. The firm of Genteur presented an interrupter of 1,000 amperes and one for 3,000 volts. M. Mornat spoke of the contacts which he had obtained with red copper, and which were very good. He also described some oil circuit breakers at 3,000 volts giving good results. The French Electrical Apparatus Company showed a bipolar interrupter for 400 amperes, a two direction bipolar interrupter for 200 amperes, and a bar circuit breaker for 3,000 volts. M. Zetter described an automatic interrupter for opening and closing at will the primary circuit of transformers branched on alternating current systems for the working of lifts. M. Ohlinger brought an interrupter for 3,000 volts and for 30 amperes, some interrupters for 50 amperes and 600 volts, and also a 3,000-volt voltmeter. A discussion was then opened by M. Hillairet on the question of circuit breakers. M. Vedovelli affirmed that sufficient precision can be obtained in the establishment of circuit breakers of low intensity, but that this is not the case with high intensities. He, however, obtained fairly good results with an alloy formed of lead, tin, and antimony. M. Hillairet then remarked that in order to thoroughly appreciate an apparatus, one should be well acquainted with its utilisation. A series of effects may be produced, for which it is as well to be prepared. For contacts, we should pay attention to the oxidising or reducing atmospheres which may be formed round the points of contact, according to whether the metals present are brass, zinc, iron, &c. These metals as well as carbon smother the arc.

Appointment.—The Manchester Tramways Committee has appointed Mr. John Eades, jun., deputy-manager of the Manchester Tramways and Carriage Company, manager of the Corporation car building and repairing works. There were 43 applicants for the post.

The Motor Vehicle in Commercial Operation.—Mr. G. H. Condict, as reported in the *Electrical Engineer* (New York) has probable turned over a new leaf, for he has been studying Scripture, and has alighted upon the book of the Prophet Ezekiel, and he has promptly raked in the vision of the Prophet anent wheels to write an article thereupon. He states an interesting fact to begin with. The motor vehicles during the recent blizzards that so disgrace the American climate, ventured and won where horses feared to tread. In comparing horse vehicles with automobiles, he thinks it necessary to remind critics that they forget when criticising the heavy automobile to reckon the weight of the horse in the horsed vehicles. This is so. People do overlook the fact that a horse is heavy. He pictures future cities served by automobiles, with smooth-faced railless streets, and no horse or any other beast (does he include rate collectors?) nor side walks, for pedestrians are on elevated tracks. As regards present day conditions, he speaks hopefully of the electrical cabs of New York. The batteries, though heavy, are so far not showing the old time faults of buckling, short circuiting, sulphating, disintegrating, &c. Tyres are still an unsettled problem, and so also are wheels. Now that vehicles driven by accumulators are at work in London (or were until quite recently), and in New York, it is certain that we must be on the road to find improvements. Without practical daily working no improvement could have been effected. If all vehicles could be power driven the question of street surface would at once solve itself in favour of asphalte. Once clean it would remain so with little trouble. The wear of streets is almost wholly due to horses' hoofs, not to the rolling contact of smooth wheels.

The City Electric Lighting Inquiry.—It will be remembered that last week Sir Courtenay Boyle asked whether the City Corporation had any particular preference for any one of the three companies which want to compete in the City Electricity Supply. The Lord Mayor is stated to have decided to call the Court together at 11.30 next Monday morning, to consider the point. The inquiry will be resumed the following day at the Guildhall.

Correspondence.—We have received several communications too late for insertion in this week's issue, among them being the following:—"The Absolute Block System of Signalling on Railways," by C. J. Little. "A Word to Municipal Works' Committees," by J. W. Beauchamp. We should be glad if our readers would remember that all matter intended for "Correspondence" columns should be received here by Wednesday afternoon.

Obituary.—We much regret to have to announce that the name of Mr. George Wm. Welch, of the firm of Welch and Fry, electrical engineers, 113, London Wall, E.C., appears among the list of missing from the ill-fated *Stella*, which went down while on its way from Southampton to Guernsey last week.

Retirement.—Mr. John Doherty, superintending engineer of the Post Office Telegraphs in the North-Western District, retires from active service to-day, April 7th. His connection with telegraphy dates back as far as 1852. It is stated in a Manchester paper that he intends devoting himself to the subject of municipal telephony.

Royal Society Conversazione.—The above will take place at Burlington House on Wednesday, May 3rd, at 9 p.m.

Train Lighting.—The directors of the South Indian Railway have approved of Stone's system of electric train lighting, and are going into the question of cost of equipping their trains.

Personal.—Mr. Douglas C. Bate, A.M.I.C.E., manager of the Stewart Electrical Syndicate, Limited, has been appointed managing director of that company.

Appointment Vacant.—The Keighley Corporation wants an electrical engineer to design and supervise an installation for electric lighting and traction. See "Official Notices."

The First Incandescent Lamps in Multiple.—In a brief article in the New York *Electrical World*, Mr. F. R. Upton delivers himself as follows:—

In the history of electrical progress I assisted at one event of first magnitude—that is, the creation of the Edison system of electric lighting.

In Menlo Park, in 1879, I remember lighting the second high-resistance carbon incandescent light in multiple arc with the first, both run from an armature of low internal resistance. There was no flicker to be seen in the first when the second was thrown on and off the circuit. Calculation had shown that there should be none, and this trial proved that the theory was correct.

The first house lighted in Menlo Park was the one opposite the railway station on the path toward the laboratory. The first dinner party by electric lights was given in this house. Lamps were hung in the corner of the parlour of the house close to the ceiling.

Mr. Grosvenor P. Lowrey, of charming memory, suggested this method of lighting, now so common. Ten years from now my anecdotage may be more pronounced; this should be enough for the present.

Royal Institution.—In addition to the after-Easter arrangements mentioned last week, on May 12th Prof. T. Preston, M.A., F.R.S., is to lecture on "Magnetic Pertubations of the Spectral Lines."

Verband Deutscher Elektrotechniker.—The annual meeting of the Verband Deutscher Elektrotechniker is to be held in Hanover from June 8th to 11th next.

NEW COMPANIES REGISTERED.

Angus Electric Light and Power Company, Limited (4,189).—This company was registered in Edinburgh on March 24th, with a capital of £25,000 in £1 shares, to carry on the business of electrical, mechanical and practical engineers, electricians, suppliers of electricity, and electrical apparatus manufacturers. The first subscribers (each with one share), are: George Scott, Park House, Brechin, manufacturer; James Mitchell, 3, Melville Gardens, Montrose, merchant; V. Story, Hill House, Montrose, M.D.; J. Valentine, British Linen Bank House, Brechin, agent;—J. Aird, Denview, Brechin, solicitor; Alex. Middleton and D. Campbell, 186, High Street, Montrose, solicitors. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, 20 shares; remuneration, as the company may determine. Registered office, 186, High Street, Montrose.

Blackburn, Starling & Co., Limited (61,302).—This company was registered on March 28th, with a capital of £12,000 in £1 shares, to acquire and carry on the business of a steeplejack, electrical, heating, ventilating, and mechanical engineer, builder and contractor carried on by Joseph Blackburn at Gresham Works, Waterway Street, Nottingham, 72, Piccadilly, Hanley, Staffs., and 12, Fleet Street, Dublin. The first subscribers (each with one share) are:—Joseph J. Blackburn, 56, Queen's Walk, Nottingham, electrical engineer; Francis H. Starling, 42, Bridgford Road, Nottingham, electrical engineer; Arthur T. Ashwell, St. Peter's Church Walk, Nottingham, solicitor; Charles Osborne, 72, Piccadilly, Hanley, Staffs., electrical engineer; George Tutin, Beeston, Notts, solicitor; Ernest M. Tinsley, 309, Lenton Boulevard, Nottingham, cashier; Edward H. Bridges, 47, Palm Street, New Basford, Nottingham, clerk. The number of directors is not to be less than three nor more than five; the first are Joseph Blackburn, Frank H. Starling, Charles Osborne, and Alfred Campbell; qualification, £500; remuneration, as fixed by the company.

Joel Electric Carriage-Motor and Battery Syndicate, Limited (61,315).—This company was registered on March 29th, with a capital of £50,000 in £1 shares, to acquire the benefit of certain existing inventions relating to secondary battery plates, electromotors, dynamos and dry electrolyte for secondary batteries, to adopt an agreement with the National Motor Carriage Syndicate, Limited, and to carry on the business of electricians, motor manufacturers, cycle makers and dealers, engineers, &c. The first subscribers (each with one share) are:—A. A. Common, 63, Eaton Rise, Ealing, W., gentleman; A. M. Tod, Trent Cottage, Burton-on-Trent, gentleman; Arthur F. Mulliner, 79, Bridge Street, Northampton, carriage builder; Henry F. Joel, 74, Windsor Road, Forest Gate, E.; F. William Potter, Withylands, St. John's Road, Harrow, engineer; Gerald de L. E. Duckworth, 22, Hyde Park Gate, W., publisher; Thomas A. Welton, chartered accountant, 22, Palace Road, Streatham, S.W. The first directors (to number not less than two nor more than six) are to be nominated by the subscribers; qualification, £100; remuneration as fixed by the company.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Hodges & Todd, Limited (58,153).—This company's statutory return was filed on March 13th, when 757 shares were taken up and paid for in full out of a capital of £25,000 in £1 shares.

Leatherhead Electric Lighting and Power Company, Limited (49,945).—This company is not now and has never been in operation.

London Electric Wire Company, Limited (36,544).—This company's annual return was filed on February 21st. The capital is £100,000 in £5 shares (10,000 preference). 6,280 preference and 6,893 ordinary have been taken up, and 3,860 of each are considered as paid. £5 per share has been called, and £27,265 paid on the others.

Julius Sax & Co., Limited (37,435).—This company's annual return was filed on January 30th, when the whole capital of £20,000 in £10 shares was taken up. 1,993 shares are considered as paid, and no calls have been made on the others.

STOCKS AND SHARES.

Wednesday Evening.

Proneness to holiday-making has ever been a feature of the Stock Exchange and its members; hence, the prolongation of the Easter recess by many of the *habitués* of Capel Court is not a bit surprising. The Electric Market has languished in neglect; some of its main props did not put in an appearance until the middle of the week, and when they mused upon the shortness of the settlement they considered it was rather a waste of time to come up to the City at all. A few lively dealings in Citys relieved the deadly monotony to a small degree. Some of the people who "banged" the price when it was considerably higher have turned round, and from 16¼ the quotation gently expanded to 17⅜, which marks a rise of ¼. Charing Cross picked up the same fraction, to 11½, after the first rush of holders to realise their new shares at a premium was over.

A strong undercurrent of strength exists in the market for the principal lighting companies' shares, and perhaps the feature of a quiet week has been the buying of Metropolitans, both the old and new shares coming into favour at 17½ and 13¼ respectively. With regard to this company, the public are apparently recovering from their disappointment over the dividend and report, while it is recognised that the potentialities of the concern are no less now than they were when the shares stood at a much higher level.

Several changes in price have been occasioned by the marking of the shares "ex dividend." County of London preference are 14½, Bournemouth and Poole 13½, both "xd." Beyond those we have already mentioned there are very few noteworthy variations. Chelsea, however, fell ½ to 8, but Notting Hill at 17 and House-to-House at 9 are unchanged, while South Londons, as well as Westminsters, are the turn harder at 3¼ and 16 respectively. Brush ordinary are neglected at 2, that is to say, par, and the 6 per cent. preference remain at 2¼. Nernst Electric are nominally quoted at ¼ discount.

The satisfactory character of the meeting of Willans & Robinson was quite enough to bring the shares into demand, the present shareholders being eager to secure the benefits which the new issue of capital will provide for them. A resolution was passed at the meeting, raising the capital of the company to half a million sterling, the new shares created thereby to be divided into ordinary and preference. Holders are offered one new share for every three old. The market price of the ordinary is 10¼ buyers, while the preference are sought for at 7½, so that the company will experience no difficulty in distributing its new shares at £7 for the ordinary and £6 for the preference. It would appear that fresh capital is needed in order to cope with the extension of the company's business.

British Electric Traction are better at 19⅜ *ex* the dividend of 12s. per share, and there is a little business doing in the preference at 14 and upwards. Buenos Ayres and Belgrano preference continue their firmness, and there have been buyers of the 5 per cent. debentures at 110 and 110½. New General Traction shares have entirely justified anticipations, and are now 5¼. Belfast "Streets," among the Provincials, are unchanged at 18.

Passiveness once more characterises the electric railway market. City and South London are negotiated upon the basis of 68 to 70, Waterloo and City stock is 110½, and Central London, fully-paid shares, stand quietly at 10.

CITY NOTES.

Messrs. Willans & Robinson, Limited.

The annual meeting of the shareholders of the above company was held on Wednesday, last week, at the Cannon Street Hotel, Mr. Mark Robinson presiding.

In moving the adoption of the report, the Chairman said the last time he had the pleasure of addressing them he began by congratulating them on the fact that he had next to nothing to say, and that they had nothing to recommend but a dividend. In rising this time to move the adoption of the report and accounts, he had a different tale to tell, for though the dividend they recommended was happily larger than ever before, he feared they must listen to a long speech, for their recommendations were extensive. Growing prosperity had brought upon them necessities which six months ago they could only foreshadow, and which they then hoped to postpone somewhat longer. He alluded, of course, to the extensions they proposed to carry out, and to the additional capital that necessitated. Let them congratulate themselves upon a successful half-year, and the more so as its success was due to reasons which seemed to promise even better results for the future. The half-year's net profit had risen from £17,521 to £22,628, an increase of over £5,000. As the paid-up capital increased during the half-year, more interest would be payable, even at the old rate, but even with this correction their real disposable increase, in comparison with the preceding half-year, was over £4,000. Profit had increased much faster than capital, which was a true test of success, and one to which he would specially direct their attention. It might be objected that they were now reaping the benefit of capital subscribed in previous years; but this was only partially true. At any rate, the improvement in profits had been for several half-years continuous, and not only continuous, but progressive. He thought they might fairly attribute it to the success of their plans for increasing the output and diminishing the cost of production; in fact, they were entitled to claim that the advice they gave four years ago, to sanction new works and a large increase of capital, had been justified by the results. That afternoon they again asked sanction for a similar step, for reasons identical with those which gained their approval then, and with results which they believed would be as satisfactory. The sum applied to depreciation was less than last time, viz., £5,013, against £5,591, which might look like retrogression in their accustomed methods of prudence. The change is due, however, to an alteration in accounts, by which they would in future deal with the replacing of certain very perishable articles otherwise than through the depreciation account. There was in reality an increase in the total sum thus applied. Next, with regard to dividend. When directors proposed a higher dividend than before, with plenty of reason to show for it, they were expected to carry themselves as those assured of the praise of all men. But they know better, because they have taken this rash step before, and remember what happened then, when, after long consideration, and much carrying to reserve, they raised their modest 7 per cent. to 8. The great body of the shareholders undoubtedly approved, but at least one shareholder thought they were rash, and *said* so. They thought the result showed that they were not, and in the proposal they now made, viz., to pay 10 per cent. on the ordinary shares, while carrying to the two reserves at the rate of no less than £11,000 per annum, they believe that they held only a fair balance between the interests of the present shareholders and those of their successors. They would notice that they carried an increased sum to the reserve fund. It is but two years since they congratulated themselves on carrying £3,000 in all to the debenture redemption fund and to the reserve fund combined. This time for the same two objects they jointly reserve £5,500, nearly twice as much, and they make still another reserve of £1,265 by increasing the sum carried forward. The paragraph showing the appropriation of the balance of the share premiums account would meet, they hoped, with approval. They had carefully considered the valuation of the Thames Ditton property and plant, and had written it down sufficiently to discount any probable chance of a serious loss in disposing of the Ditton property, should they decide later (as no doubt they would) to remove the whole of the plant to Rugby. They had paid all the expenses of the move, and had still kept a little in hand for clearing up old matters which remained unsettled in connection with it. And finally had added £5,000 to their already handsome reserve fund. The growth of the reserve fund gave them solid ground for congratulation, and the fact that they have completed five years of existence also, perhaps, gave them some excuse for talking about it. The figures showed not only great advance, but progressive advance; the increased amount of capital they had put into the business had justified itself by improving the returns upon what was there before. It was with the conviction that the same result may reasonably be expected to follow, that they now asked the shareholders' sanction to a further increase. That they might not have to trouble them again in the same way, they proposed to raise the authorised share capital at once from £300,000 to £500,000, but they did not contemplate issuing at present more than £100,000. It would be idle to say that they looked upon the business as anything but a highly progressive one, and, in fact, they believe that, under the conditions of trade which were now arising, advance was not only safe but necessary; that for them standing still meant going back. Therefore they did not pretend to any strong hope that they would stop at £100,000 for more than a couple of years or so, but they might rely upon their stopping there as long as they possibly could. They believed the electrical industry, whether in municipal hands or others, was about to make great advances. Much more horse-power would be wanted, and much larger engines. In past forecasts of the plant and space they should be likely to require in the future, they had been sometimes charged with rashness, but, in fact, they had been too timid, and as the size of the engines required for driving dynamos had increased, they had sometimes been found unprepared, and the first orders for the larger sizes had gone elsewhere. Happily they had been able to divert the new stream of business, or a sufficient part of it, back to their own shops, when, later, they had qualified themselves to receive it. But they might not be so fortunate if they again neglected the signs of the times, while even if the probabilities of very large work coming their way were much less than they were, it would still answer their purpose to enlarge their shops and put down heavier tools, if only for the excellent position it would put them in for taking orders for early delivery. The main feature of their proposals, however, was, that they proposed to extend the machine shop chiefly by moving the boiler work altogether from Rugby, at some saving, of course, in the extensions at Rugby, but at the cost of building new works elsewhere. An excellent site had been secured near Chester, on a 99 years' lease, at a satisfactory rental. It abutted on one side upon the North-Western Railway, and upon the lower part of the river Dee on the other, so that they would be able to bring moderate sized coasters, both sailing and steam, alongside their own wharf. A colliery siding connected with their own. They had secured 30 acres, so as to have plenty of room for storage and for extensions. Probably the crucial question they would desire to put was, Why have they thus come to the conclusion that a business they intended to work as a mere adjunct to the engine business at Rugby, and which, in fact, they had practically not worked at all, was now worthy of works of its own, and of a large investment of capital? What had changed in the position? The slow progress they had made in developing the Niclausse boiler business had been frequently commented upon, and none of them have liked it. Let him tell them the reasons. The water-tube boiler of the various French types was essentially foreign in details, and though they took long to consider the design before adopting it, and put it through many tests, they never doubted that long practical use in this country would show the need of changes of some kind. That, in their opinion, had happened. The design was all they thought it, and they believed there was no boiler in the world so good, but they wished to meet English views, or even English prejudices, to modify some points of construction—not of design. They had to make certain changes in the methods of manufacture, which in a sense disqualified the boiler from being made upon the scale, and by the means which they first contemplated. At the same time, by excellent luck, they could find other uses for the Rugby boiler shop, with only small loss in shifting, or even in selling, the special boiler tools they have so far laid down. Should they abandon the Niclausse boiler, and write off the not very serious amount of capital they had locked up in it? That was the question before them. But while their views about the construction of the boiler had developed, so also had the public demand for water-tube boilers, and so also had their views about the value of the Niclausse boiler. They were confident that it was good enough to make upon the largest scale, and that a corresponding demand for it exists, and further that it promised to add to their business an even more profitable branch than they supposed at first. These, he said, were in outline the reasons which had led the directors to propose to use the present boiler shop as an additional machine shop, and to start new boiler shops elsewhere, and so leave the Rugby site in its entirety for the growth of their engine business. The chairman then described how it was proposed to issue the capital, and said if the scheme was adopted the company would receive £30,000 in premiums.

Mr. P. Boulnois seconded the motion, which was adopted, and subsequently the necessary resolutions for the creation of the additional capital was carried.

A Batch of German Company Reports.

In a previous issue we made some remarks upon the success of German financial methods in the promotion of industrial undertakings, and we pointed out the advantage of these, as compared with the usual methods of procedure in our own country. (*See* Electrical Review, October 14th, 1898.)

We give below abstracts of the last reports of three of the larger electrical companies, which fully bear out our remarks. These reports give evidence of most astounding growth and enterprise.

The chief feature of the larger German electrical manufacturing companies is undoubtedly *their readiness and ability to provide complete equipments* for electric light or power stations, and also to undertake traction work in all its branches.

In this country half-a-dozen manufacturers are required to provide the machinery and apparatus for even a small lighting station. In Germany one manufacturing firm will undertake to provide every requisite for a small 2-H.P. sewing machine installation worked from the mains, or for a 5,000-H.P. traction scheme with a generating station miles away, and run by water-power. Manufacturers in this country may shake their heads over this comprehensiveness of operations, but the proof of the pudding is in the eating, and we commend the facts and figures given in the reports below to the attention of financiers and shareholders interested in the electrical engineering industry in this country. While English manufacturing firms have been occupied in meeting the home demand for electrical machinery and apparatus (and not always with success, even in this limited field) the Germans have been monopolising the outer world; and to-day it would be difficult to name a single country in which there is not practical evidence of their enterprise and skill in the domain of applied electrical science.

First Report of the Elektrische Licht u. Kraft-Anlagen A. Gesellschaft, Berlin.

The following figures concerning the above company are taken from the issue of the *Elektrotechnische Zeitschrift* for November 24th, 1898. The report only covers the period from December 1st, 1897, to September 30th, 1898, and therefore does not represent a full year's work. The capital of the company is £1,500,000; of this total

£937,500 has been paid up. The directors have not yet invested a large portion of the capital at their disposal, but during the period under review, blocks of shares in the Wiener Tramways Gesellschaft, in Siemens & Halske, and in the Brazilian Elektricitäts Gesellschaft have been purchased. The latter company was promoted by a group of German companies, and has purchased the Villa Izabel Tramway in Rio de Janeiro, Brazil, with a view to substituting electricity for the present horse-power by which the line is worked.

The same company has also obtained a concession for supplying a telephonic system in Rio. Siemens & Halske, of Berlin, have this portion of the scheme in hand.

The net profits of the Elektrische Licht u. Kraft-Anlagen A G. during the period of 10 months since its incorporation, have been £39,778. Of this total 5 per cent. interest on the capital ranking for dividend will absorb £35,212; and £513 is to be carried forward to the next account. The latter sum is certainly small, compared with the amount distributed as dividend.

Report of Annual Meeting of Siemens & Halske, Berlin.

The annual meeting of the shareholders of this company was held on December 21st last, and is reported in the *Elektrotechnische Zeitschrift* of December 29th, 1898. The report covers the year ending July 31st, 1898, and the profits permit of a dividend of 10 per cent. The directors state that the volume of business is increasing, but prices are diminishing, and this position necessitates the enlargement of the manufacturing plant of the company.

With regard to central station work, 24 installations were commenced during the year, 11 were completed, and 12 extensions were in progress.

The year had been a busy one in electric traction work. Lines had been completed at Copenhagen, Schwelm, Darmstadt, Turin, Berlin, Bochun, Hagen, Waldenburg, Vienna, and Buda-Pesth, Extensions were carried out at Barmen, Basle, Dresden, Hanover, Charlottenburg, Buda-Pesth, and Vienna.

The financial statement contains the following figures:—

Gross profits	... £446,768
Net profits	... 276,553
Dividend 10 per cent. on £1,750,000 ...	... £175,000
Reserve fund	... 11,995
Bonus to officials and work-people ...	... 17,500
Commission to directors and managers	... 6,145
Carried forward	65,912
	£276,552

During the past year the share capital of the company has been increased by £250,000 and it now stands at £2,000,000.

The new issue, however, does not rank for dividend until the next financial year. The directors close their report with the significant statement that "the centre of gravity of the company lies in its manufacturing operations—not in its promotion work." This would appear to be a reference to the more enterprising, and possibly less safe, procedure of the Allgemeine.

The Fifteenth Annual Report of the Allgemeine Elektricitäts Aktien Gesellschaft of Berlin.

The *Elektrotechnische Zeitschrift* of December 1st last contains a very detailed statement of the affairs of this company.

The share capital of the company now stands at £1,750,000, and the result of the last year's operations permit of the payment of a 15 per cent. dividend upon this sum.

The company employs 12,000 workpeople, the greater proportion of whom are engaged in the company's factories.

During the past year a special factory has been started for the production of small motors and dynamos.

The following figures show the rapid growth of this company:—

	Factory operatives. No.	Output of dynamos and motors.	
		Number.	Horse-power.
1893–4	1,214	1,555	20,400
1894–5	—	2,049	30,000
1895–6	3,940	4,000	68,000
1896–7	—	5,189	103,000
1897–8	6,011	8,328	152,900

The newly-erected cable works at Oberspree has already become unable to supply the demand; 4,000 tons of copper were used in this works in the year 1897-98. The incandescence lamp sales have grown by 900,000 during the year. The Nernst lamp has been perfected in the company's laboratory during the period under review, and is about to be placed on the market.

The company now possesses agencies in 139 towns in Germany or abroad.

As regards tramway work, up to the end of June, 1898, 55 tramways had been equipped, or were in process of equipment, by the company. The aggregate length of these 55 systems is 1,095 kilometres, and 1,861 motors are employed in working them. Extensions of many of these systems are already in progress. The directors of the company expect a great development of electric traction for interurban communication, and they have arranged to build electric locomotives for use on branch local lines of railway.

Details of 32 electric tramway schemes in which the company is interested are given in the report. In addition to undertakings of this character in Germany, the company is equipping lines in Seville, Bilbao, Christiania, Barcelona, Genoa, Santiago de Chili and Buenos Ayres; while 20 new schemes are at present being reported upon.

The central station and power business of the company is proceeding satisfactorily. During the past year, 15 central stations with generating capacity of 11,500 kw., and 28 factories with 41,000 kw. have been equipped by the company. The erection of central light and power generating stations in sparsely inhabited districts is also being pushed, as a special branch of the business.

The electro-chemical industrial developments which are about to occur in France, Norway and Austria, will bring further power installation business to the company, which also retains a share interest in these new ventures.

The chief figures in the financial statement of the directors are presented below:—

Gross profits for year 1897-98	... £406,120
Net profits " "	... 342,657
15 per cent. dividend on £1,250,000	... £187,500
7½ " " £500,000	37,500
Directors' commission	22,500
Manager's commission	11,250
Bonus to officials and contribution to pension fund ...	11,250
Social agencies (Wohlfahrtseinrichtungen)	11,250
Carried forward	11,407

The directors are working out the details of a sick and pension fund scheme to supplement the State grants. Among the assets of the company are 48 German and 140 foreign patents.

At the general meeting of the shareholders, in answer to inquiries, it was stated that the price paid for the German patent rights of the Nernst lamp did not run into millions of marks, and that it was already written off in the accounts. [Since the difference between the gross and net profits is only £63,463, we may presume that it must have been less than this sum.]

The company, at the date of the annual meeting, had £5,600,000 worth of work in hand, and it was expected that orders to the value of £2,500,000 would come in when the transfer of the Berlin central lighting station to the town authorities was settled.

Stock Exchange Notices.—The Stock Exchange Committee have (1) appointed special settling days as under:—Wednesday, April 12th.—Chelsea Electricity Supply Company, Limited—further issue of £40,000 4½ per cent. debenture stock. New General Traction Company, Limited—24,000 ordinary shares of £5 each, fully paid, Nos. 10,001 to 34,000; and (2) ordered the undermentioned securities to be quoted in the Official List:—British Electric Traction Company, Limited—further issue of £100,000 5 per cent. perpetual debenture stock; Calcutta Electric Supply Corporation, Limited—20,000 shares of £5 each, £3 paid, Nos. 1 to 20,000; New General Traction Company, Limited—24,000 ordinary shares of £5 each, fully paid, Nos. 10,001 to 34,000.

Chloride Electrical Storage Syndicate.—An interim half-yearly dividend at the rate of 7 per cent. per annum has just been paid by this syndicate.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending April 1st, 1899, were £433 0s. 4d.; aggregate to date, £2,520 18s. 9d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending March 31st, 1899, were £2,745 18s. 9d.; corresponding period, 1898, £2,339 11s. 6d.; increase, £406 7s. 3d.

The City and South London Railway Company.—The receipts for the week ending April 2nd, 1899, were £889; week ending April 3rd, 1898, £1,050; decrease, £161; total receipts for half-year, 1899, £16,275; corresponding period, 1898, £14,942; increase, £333. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending April 1st, 1899, were £199 6s. 2d.; week ending April 2nd, 1898, £117 16s.; increase, £81 10s. 2d. Total receipts to date, 1899, £1,895 19s.; corresponding period, 1898, £1,395 14s. 7d.; increase, £500 4s. 5d. Miles of track open week ending April 1st, 1899, 3; week ending April 2nd, 1898, 3. Car miles run week ending April 1st, 1899, 4,405; week ending April 2nd, 1898, 3,167. Number of cars, week ending April 2nd, 1899, 12; week ending April 2nd, 1898, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, March 31st, 1899, were as follows:—D. U. T. Co., horse cars, £1,715 19s. 4d.; ditto, electric cars, £1,006 13s. 1d.; D. S. D. Co., electric cars, £721 13s. 4d.; total, £3,444 5s. 9d.; corresponding week last year—D. U. T. Co., horse cars, £3,184 5s. 4d.; ditto, electric cars, £506 16s. 11d.; D. S. D. Co., electric cars, £352 7s. 5d.; total, £2,843 9s. 8d.; increase, £600 16s. 1d.; aggregate to date, £41,550 17s. 10d.; ditto last year, £39,118 0s. 11d.; increase to date, £2,432 16s. 11d. Worked:—The mileage open is 18 miles electrically, 26 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways.—The receipts for the week ending March 15th, 1899, were £356; total receipts to date, March 15th, 1899, from June 29th, 1898, £10,085. Miles of track open, 3½. Car miles run, 5,573. Number of cars, 10. The receipts for the week ending March 22nd, 1899, were £315; total receipts to date, March 22nd, 1899, £10,400. Miles of track open, 3½. Car miles run, 6,292. Number of cars, 10.

The Liverpool Overhead Railway Company.—The receipts for the week ending April 2nd, 1899, amounted to £1,405; corresponding week last year, £1,313; increase, £92.

The South Staffordshire Tramways Company.—The receipts for week ending March 31st, 1899, were £572 5s. 9d.; aggregate receipts for 13 weeks, £7,664 18s.; week ending April 1st, 1898, £567 11s. 11d.; aggregate receipts for 13 weeks, £7,472 3s. 4d.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, March 28th.	Closing Quotation, April 5th.	Business done during week ended April 5th, 1899. Highest	Lowest
124,400£	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	87 — 92	87 — 92	...	...
905,560£	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	65 — 68	65 — 68	65½	...
3,047,220£	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	117½—118½	117½—118½	118¾	117¾
3,047,220£	Do. do. Deferred...	Stock	...	...	18s. %	14½— 15	14½— 15	...	...
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	...	16 — 16½	15¾— 16¼xd	16 1/16	15 7/8
75,000£	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2½— 3	2½— 3	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	8 %	190 —200	185 —195 xd	...	...
1,332,523£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	105 —107	104 —106 xd	106	105⅝
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	...	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Telegraph	10	8 %	7 %	...	9 — 10	9 — 10	10	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	17½ — 18½	18 — 19	18½	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5 xd	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11 xd	10½	...
30,000£	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	...	106 —109%	106 —109%	...	...
60,710£	Direct United States Cable	20	2½ %	...	...	12¼— 12¾	12¼— 12¾xd	12¼	...
120,000	Direct West India Cable, 4½ % Reg. Deb. ...	100	...	...	...	103 —106	103 —106	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	...	...	...	180 —185	179 —184	181½	180
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	102 —105	102 —105	...	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	99 —102	99 —102	...	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	125 —129	125 —129	...	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	18 — 18½	18 — 18½	18½	18⅛
16,200£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	99 —103	99 —103	...	...
64,400£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	125 —129	125 —129	...	...
35,100£	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	99 —103	99 —103	...	...
46,500£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	100 —103	100 —103	...	...
300,000£	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	102 —105	102 —105	102½	...
200,000£	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	104 —107%	104 —107%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	...	12⅜— 13¼	12⅜— 13¼	13⅛	12⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	16¾— 17¼	16¾— 17¼	...	...
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	30 — 31	30 — 31	...	...
97,800	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	57 — 60	57 — 60	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	108 —111	108 —111	...	...
484,597	National Telephone, 1 to 484,597	5	5½ %	6 %	6 %	4½— 5	4½— 5	4⅝	4½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅜— 5¼	4⅜— 5¼	4 15/16	4 13/16
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	99 —101	99 —101	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅞— 1	⅞— 1	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	...	6½— 7½	6½— 7½	7	...
3,381	Submarine Cables Trust	Cert.	...	...	...	140 —145	140 —145	...	...
58,000	United River Plate Telephone	5	5 %	6 %	...	4⅜— 5¼	4⅜— 5¼	4⅞	...
151,733£	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000£	West African Telegraph, 5 % Debs.	100	5 %	5 %	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	103 —106	103 —106	...	...
389,521	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Telegraph	10	1 %	‡2 %	...	2 — 2¼	2 — 2¼	2⅛	2 1/16
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	10½— 11	10½— 11	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	9 — 10	9 — 10	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	105 —108	105 —108	...	...
158,100£	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	10 — 12	11 — 12	11⅜	11⅛
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	6 %	6 %	8 — 9	7½— 8½	8⅝	7⅞
60,000	Do. do. do. % Deb. Stock Red....	Stock	4½ %	4½ %	...	114 —116	114 —116	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	7 %	10 %	6 %	17 — 18	17 — 18	17⅝	16⅝
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15 — 16	15 — 16	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	124 —129	124 —129	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	*nil*	11 — 12	11 — 12	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14 — 15	14 — 15 xd	...	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	5 %	...	5¼— 5⅜	5¼— 5⅜	...	...
15,661	House-to-House Electric Light Supply, Ord., 101 to 15,761	5	...	4 %	6 %	8½— 9½	8½— 9½	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	...	9 — 10	9 — 10	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3½— 4	3½— 4	...	...
48,050	Do. do. do. 6 % Pref.	5	...	...	6 %	6½— 7	6½— 7	6¾	...
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	105 —107	105 —107	...	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	5 %	16½— 17½	17 — 18 xd	17½	...
22,500	Do. Nos. 62,501 to 85,000, £7 paid ...	10	...	...	...	12½— 13½	13 — 14 xd	...	...
220,000£	Do. 4½ % First Mortgage Debenture Stock	...	4½%	4½%	...	117 —120	117 —120	...	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	6 %	16½— 17½xd	16½— 17½	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½%	14½%	14½%	17 — 18	17 — 18	17⅝	17 11/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	...	...
65,000	South London Electricity Supply, Ord., £3 paid	5	...	...	...	3½— 3⅝	3½— 3⅝	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	9 %	12 %	12 %	15½— 16½	15½— 16½	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation Mar. 28th.	Closing Quotation April 5th.	Business done during week ended April 5th. 1899. Highest	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	...	...	...	3 — 3½	3 — 3½	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	94 —100	95 —100 xd	...	...
30,000	British Electric Traction	10	...	...	6 %	19½— 20	19½— 20 xd	...	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13⅜— 14½	13⅜— 14½	14 1/16	...
100,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	126 —129	125 —128 xd	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	*nil*	*nil*	...	1⅞— 2⅛	1⅞— 2⅛	2	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	*nil*	4 %	...	2⅛— 2⅜	2⅛— 2⅜	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	102	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	...	...	...	12⅛— 13⅛	12⅛— 13⅛	...	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	114 —117	114 —117	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	9⅜— 10¼	9⅜— 10¼	10	...
178,303	Do. do. do. £8 paid	10	...	...	...	7¾— 8¼	7¾— 8¼	...	...
61,033	Do. do. Pref. half-shares £3 paid ...	...	...	...	...	3¾— 4	3¾— 4	...	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	4¼— 4⅜	4¼— 4⅜	...	...
630,000*l*	City and South London Railway	Stock	1 9/16 %	1⅞%	2⅛%	68 — 70	68 — 70	69½	68½
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £5 pd.	10	...	...	...	4⅜— 5¼	4⅜— 5¼	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	3¼— 3⅜	3¼— 3⅜	...	...
82,850	Do. 5% 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	98 —101	98 — 101	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5½%	6 %	...	2 — 2½	2 — 2½	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5½%	6 %	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	97 — 99	97 — 99	...	...
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2⅛— 2⅜	2⅛— 2⅜	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	3 — 3½	3 — 3½	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —106	103 —106	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	¼— ¾	¼— ¾	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	½— ¾	½— ¾	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 12	10 — 12	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	10 %	12 %	14 %	26 — 27	25½— 26½	26¼	25⅞
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18½— 19½	18½— 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	...	112 —115	112 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21½— 22½	21½— 22½	22⅛	21 13/16
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	101 —105	101 —105	102	101½
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	3½%	3¼%	9 15/16—10 1/16	10 — 10⅛	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	14⅝— 14⅞	14⅝— 14⅞	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	38 — 42	37 — 41	39¾	38
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	105 —108	105 —108	...	...
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	9¾— 10¼	9¾— 10¼	9 15/16	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5¾— 6¼	5¾— 6¼ xd	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	109 —112	109 —112	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10⅛.
British Aluminium, Ordinary, 10½—11; 7 % Pref., 12—13.
House-to-House, 4½% Debentures of £100, 105—108.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 13—13½; 1st Preference Cumulative 6%, £5 (fully paid), 7½—8. Debentures, 107—110. Dividend, 1898, on Ordinary Shares 10%.
National Electric Free Wiring, 10s. paid, 8s.—10s.
Smithfield Market Electric, 4—4½.
*T. Parker, £10 (fully paid), 16.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (February 2nd, 1899).

MARKET QUOTATIONS, Wednesday, April 5th.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a „ Nitric .. .. .. per cwt.	22/-	22/-	..
a „ Oxalic .. .. .. per cwt.	32/-	32/-	..
a „ Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	37/-	37/-	..
a Ammonia, Muriate (grey) .. per ton	£19	£19	..
a „ „ (white) .. per ton	£26	£26	..
a Bleaching powder .. .. per ton	£5 15	£5 15	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a „ (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£25 10	£25 10	..
a Lead, Nitrate .. .. .. per ton	£23 10	£23 10	..
a „ White Sugar .. .. .. per ton	£30 10	£30 10	..
a „ Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	8¾d.	8¾d.	..
a „ Caustic (75/80 %) .. per ton	£24	£24	..
a „ Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	68/-	68/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6 15	£6 15	..
a „ Recovered .. .. per ton	£5 15	£5 15	..
a „ Lump .. .. .. per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
a „ Crystals .. .. .. per ton	£3	£3	..
a „ Bichromate, casks .. per lb.	3d.	3d.	..
METALS, &c.			
b Aluminium Wire, in ton lots .. per ton	£224	£224	..
b „ Sheet, in ton lots.. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£65 to £130	£65 to £130	..
c Brass (rolled metal 9" to 12") basis per lb.	7¾d.	7¾d.	..
c „ Tube (brazed) .. .. per lb.	10d.	10d.	..
c „ Wire, basis .. .. per lb.	8d.	8d.	..

METALS, &c. (*continued*).	This week.	Last week.	Increase or Decrease.
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f „ Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£80	£78	£2 inc.
g „ Wire (basis price) .. per lb.	9½d.	9¾d.	¼d. dec.
g „ Sheet .. .. .. per ton	£80	£78	£2 inc.
g „ Rod .. .. .. per ton	£80	£78	£2 inc.
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	6/-	6/-	..
h India-rubber, Para fine .. per lb.	4/4	4/4½	½d. dec.
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i „ Pig (Cleveland warrants) per ton	48/9	48/3	6d. inc.
i „ Forgings, according to size per ton	From £11	From £11	..
i „ Scrap, heavy .. .. per ton	50/- to 55/-	50/- to 55/-	..
i „ Wire galvanised No. 8 .. per ton	£9 5	£9 5	..
g Lead, English Ingot .. .. per ton	£14 12 6	£14 10	2/6 inc.
g „ „ Sheet .. .. per ton	£15 10	£15 2 6	7/6 inc.
l Mica (uncut slabs 8" long) .. per lb.	6/6	6/6	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£8 5	£8 5	..
p Phosphor Bronze, plain castings per lb.	1/- to 1/4	1/- to 1/4	..
p „ rolled bars & rods per lb.	1/- to 1/4	1/- to 1/4	..
p „ r'l'd strip & sheet per lb.	From 1/2	From 1/2	..
o Platinum .. .. per oz.	£3 10	£3 10	..
p Silicium Bronze Wire .. .. per lb.	10d. to 1/1	10d. to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£115	£112	£3 inc.
g „ foil .. .. per lb.	1/6	1/6	..
n „ wire Nos. 1 to 16 .. .. per lb.	1/6	1/6	..
p White Anti-friction Metals— "White Ant" brand .. per ton	£40 to £65	£40 to £65	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	7½d.	7½d.	..
j „ Flax, 6 or 8 lea... .. per lb.	4d.	4d.	..
j „ Hemp, 3 ply 10 lbs. .. per lb.	3½d.	3½d.	..
j „ „ Russian, 10 lbs. per lb.	4½d.	4½d.	..
j „ Jute, 180 lbs. rove .. per ton	£12	£12	..
j „ Manila, 24 thread .. per ton	£35 10	£34 10	£1 inc.
k Zinc, Sheet (Vielle Montagne bnd.) p.t.	£31	£31	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d
e

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yeo & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
l Messrs. Sanders, Wake & Co.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

INSTITUTION OF ELECTRICAL ENGINEERS.

THE HISSING OF THE ELECTRIC ARC. By Mrs. AYRTON. (Read on March 23rd, 1899.)

(*Continued from page* 528.)

IN Table II. two sets of currents are dealt with, viz., the largest silent current for various lengths of arc, and a hissing current of 25 amperes; and, for each of these sets of currents and lengths of arc, two P.D.'s are given, viz., the P.D. between the main carbons, and the P.D. between the positive carbon and the arc itself.

TABLE II.

P.D. BETWEEN CARBONS, AND P.D. BETWEEN POSITIVE CARBON AND ARC WITH LARGEST SILENT CURRENT AND WITH HISSING CURRENT OF 25 AMPERES.

CARBONS: Positive, 11 mm s lid; negative, 9 mm solid.

Length of arc in millimetres.	Largest silent current.		Hissing current of 25 amperes.	
	P.D. between carbons in volts.	P.D. between positive carbon and arc in volts (calculated).	P.D. between carbons in volts.	P.D. between positive carbon and arc in volts.
(1)	(2)	(3)	(4)	(5)
1	42·2	32·1	32·1	24·4
2	44 5	32 2	34 6	25·2
3	47 5	32·3	37·0	25 7
4	49 4	32·4	40 5	25 7
5	53 0	32 5	43·9	27 9
6	55·5	32 6	45 9	27 2

Now, in order to compare the change in the P.D. between the main carbons caused by hissing, with the corresponding change in the P.D. between the positive carbon and the arc, we must subtract column (4) of Table II. from column (2), and column (5) from column (3), and compare the differences. These differences are given in Table III.

TABLE III.

DIMINUTION OF P.D. BETWEEN CARBONS DUE TO HISSING COMPARED WITH CORRESPONDING DIMINUTION OF P.D. BETWEEN POSITIVE CARBON AND ARC.

CARBONS: Positive, 11 mm. solid; Negative, 9 mm. solid.

Length of arc in millimetres.	Diminution of P.D. between carbons due to hissing.	Diminution of P.D. between positive carbon and arc due to hissing.
(1)	(2)	(3)
1	10 1	7·7
2	9 9	7 0
3	10·5	6 6
4	8·9	6 7
5	9·1	4·6
6	9 6	5·4

Thus for the lengths of arc dealt with, hissing causes a mean fall of about 9·7 volts in the total P.D. between the main carbons, and a mean fall of about 6·3 volts in the P.D. between the positive carbon and the arc. Hence of the whole diminution of the P.D. between the carbons caused by hissing, about two-thirds takes place at the junction of the positive carbon and the arc.

Further, my experiments showed that very little of the remainder of the diminution, if any, was due to a fall of the P.D. between the arc and the negative carbon; therefore this remaining diminution must be attributed to a lowering of the resistance of the arc itself. We may sum up these results as follows:—

Of the total diminution of the P.D. between the carbons caused by hissing, about two-thirds takes place at the junction of the positive carbon and the arc, and the remaining third seems to be due to a lowering of the resistance of the arc itself.

From fig. 1 it might be supposed that, given the length of the arc, the increase of current that abruptly occurs as the arc starts hissing was as definite for that length of arc as the diminution in the P.D. And this, for a long time, I imagined to be the case. But, while trying to find out what law connected the smallest hissing current with the length of the arc, I saw that the value of that current really depended on the circuit *outside* the arc.

For, let E be the E.M.F. in volts of the generator, which we will assume to be constant and independent of the current;

" r " resistance in ohms of the whole circuit *outside* the arc;

" l " length of the arc in millimetres;

" A " largest silent current in amperes;

" V " corresponding P.D. between the carbons in volts;

" A′ " smallest hissing current in amperes;

" V′ " corresponding P.D. in volts,

$$\text{then } E = V + A\,r$$

$$\text{and } E = V' + A'\,r,$$

$$\therefore \frac{A' - A}{V - V'} = \frac{1}{r}$$

that is, the sudden increase of current when hissing begins equals the product of the sudden diminution of the P.D. into the conductance of the circuit outside the arc.

$$\text{Again, } \frac{A'}{A} = \frac{E - V'}{E - V},$$

$$\text{or, } A = \frac{E - V'}{E - V} A,$$

but for a given hissing point, for example, B (fig. 1), V, V′, and A are all constants; therefore, for such a point A′ depends simply on E.

In fact, for a fixed point, B, and a fixed line, F G, the position of the point, F, merely depends on the slope we give to the line, E B F; that is, on the point on the axis of P.D. we select for E. And a consideration of the figure shows that the distance between this point, E, and the axis of current measures E, the E M F. of the dynamo. Consequently it now appears that the dotted lines in the unstable region constitute records of the particular E.M.Fs. the dynamo was made to give on the various days when the experiments were made with the different lengths of arc, several years ago.

Hence, when the largest silent current changes to the smallest hissing current for the same length of arc, the value of that smallest hissing current depends on the E.M.F. of the generator only.

Thus, it is possible, by choosing suitable E M Fs., to make the sudden smallest hissing current have any value greater than that of the largest silent current for the same length of arc. It is evident from fig. 1 that the smaller the E.M.F. of the generator, the larger will be the value of the smallest hissing current, for the lower down will E be on the axis of P.D., and therefore the farther will the point, F, be along the line, F G. This explains a circumstance that puzzled me greatly when it happened, but which is now perfectly comprehensible. Some years ago I was using accumulators to maintain an arc, and employing as small a number of cells as possible. I was able to have quite a moderate current as long as the arc was silent, but as soon as it began to hiss, the current rushed up to some huge value which would inevitably have ruined the cells, if I had not had a cut-out arranged to break the circuit. Why the first hissing current should be so much greater than I was accustomed to find it with the dynamos I ordinarily used, I could not imagine, but the reason is now perfectly obvious. The hissing current was so great simply because the E.M F. of the cells was so small, and had it been possible to maintain a silent arc without any resistance in the outside circuit except that of the cells, which is what I was trying to accomplish, I might, except for the cut-out coming into operation, have had practically an infinite current when the arc began to hiss.

We now pass from the consideration of the electrical measurements of the arc to the appearance of the crater, arc, and carbons.

Every alteration of the current and of the distance between the carbons naturally produces a corresponding modification of all parts of the arc, but until the value of the current attains a certain magnitude, which depends only on the length of the arc with a given pair of carbons, this change is one of degree merely, and not of character. A greater current simply produces a larger crater, a larger arc, and longer points to the carbons. When the special current is reached, however, a change which is no longer merely one of degree, takes

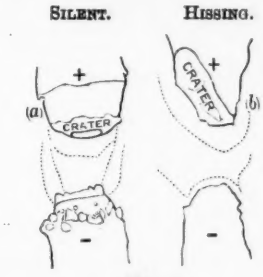


FIG. 4.

CARBONS.—Positive, 9 mm. cored; negative, 8 mm. solid.

LENGTH OF ARC.—(*a*) 5 mm.; (*b*) 8 mm.

CURRENT.—(*a*) 3·5 amperes; (*b*) 34 amperes.

place in the crater. Instead of presenting a uniformly bright surface to the eye, this becomes partly covered with what appear to be alternately bright and dark bands in one or more sets of concentric circles, moving round different centres in opposite directions. The directions of rotation and the entire positions of the images change continually, and the motion grows faster and faster as the current is increased.

It is impossible that these figures, which do not move too fast to be clearly seen by the eye in an image of the arc magnified only 10 times, should have escaped the observation of all those who have made a study of the arc, and yet, after a careful search I can find no mention of them anywhere.

When the current is so much increased that the motion becomes too fast for the eye to detect, the arc begins to hum, and then, as Mr. Trotter* first showed in 1894, it rotates at the rate of from 50 to 450 revolutions per second. These rapid revolutions, which the unaided eye is incapable of observing, he discovered by the use of a disc having alternate arms and spaces, and kept in rapid rotation; but, in his account of his observations, he makes no reference to the relatively slow rotations which *precede* the hum. In fact, the rotations observed by Mr. Trotter appear to begin just where those I have

* *Pro. Roy. Soc*, 1894, Vol. lvi., p. 262.

been describing become too quick for the eye to see unaided, and end just as the arc begins to hiss, for he mentions that at 450 revolutions per second the arc breaks into a hiss.

As soon as hissing begins the whole appearance of the crater changes again; a sort of cloud seems to draw in round a part of it, moving from the outer edge inwards, and varying continually in shape and position. Sometimes but one bright spot is left, sometimes several, but always the surface is divided into bright and dull parts, giving it a mottled appearance, as is slightly indicated in (*b*) fig. 4. If, then, the current be diminished, so that the arc becomes silent again, the whole surface of the crater grows dark for an instant, then brightens in spots, and finally becomes bright again all over.

The vaporous arc itself undergoes fewer modifications; it preserves the ordinary characteristics of the silent arc while dancing circles hold possession of the crater, but when humming begins a green light is seen to issue from the crater, and with hissing this becomes enlarged and intensified, till the whole centre of the purple core is occupied by a brilliant greenish-blue light, as is indicated in fig. 5. The *shape* of the arc now alters also. While it is silent or humming no great difference can be observed in its form. With solid carbons it is rounded or pear-shaped according to its length, and has an appearance of great stability. But as soon as hissing occurs the arc seems to suddenly dart out from between the carbons and to become flattened out, as if under the influence of a centrifugal force acting at right angles to the common axis of the two carbons. In fig. 5 this flattened appearance is well marked, as it is also in (*d*) fig. 6; and indeed these figures show that every part of the vaporous arc itself is involved in this flattening—the purple core, the shadow round it, and the green aureole—as if they were all revolving with great rapidity round a common axis. And what more likely than that this is the case, since, as has already been mentioned, the arc is revolving at the rate of 450 revolutions per second *at the moment that it starts hissing?*

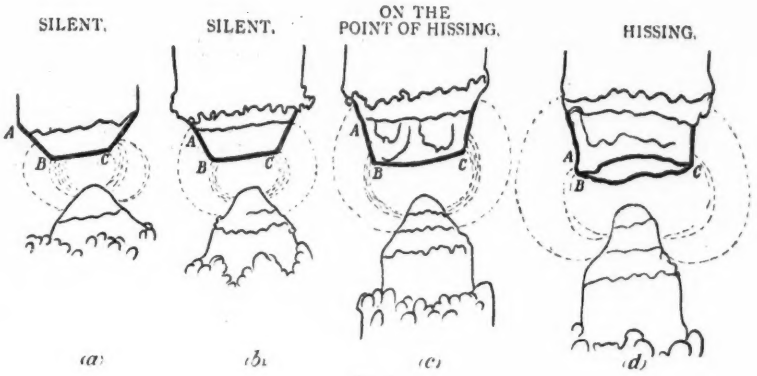


FIG. 6

CARBONS.—Positive, 11 mm. solid; negative, 9 mm. solid.
LENGTH OF ARC, 2 mm.
CURRENT.—(*a*) 6 amperes, (*b*) 12 amperes, (*c*) 20 amperes, (*d*) 30 amperes.

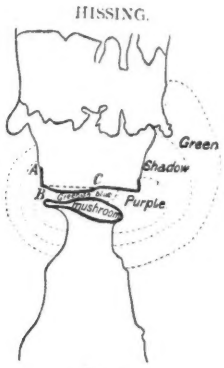


FIG. 5

CARBONS.—Positive, 11 mm. solid; negative, 9 mm. solid.

Length of arc, 1·5 mm.; current, 28·5 amperes.

As regards the carbons themselves, the only important modification of the *negative* carbon that appears to be due to hissing is the formation of the well-known "mushroom" at the end of that carbon with a *short* hissing arc. This mushroom, of which a good example is seen in fig. 5, is well named, not only because of its shape, but also because of the rapidity of its growth, which is so great that while it is forming the carbons often have to be *separated*, instead of being *brought together*, to keep the length of the arc constant.

And now we come to the most important of all the changes that take place when the arc begins to hiss, viz., the alteration in the shape of the *positive* carbon.

(*To be continued.*)

EXPENDITURE UPON MUNICIPAL ELECTRIC LIGHTING UNDERTAKINGS.

It will be remembered that on the suggestion of Sir Henry Fowler the House of Commons last August ordered the preparation of a return "of the water, gas, tramway, electric lighting and other reproductive undertakings carried on by municipal boroughs."

Such return has now been issued, and we have abstracted from it the figures relating to electric lighting undertakings. It must be noted that the figures are only brought up to the end of March, 1898.

	Capital.					Income.				
1	2	3	4	5	6	7	8	9	10	11
Name of undertaking.	Total capital, inclusive of borrowed capital, provided by corporation.	Amount of capital borrowed.	Amount of capital borrowed which has been paid off.	Balance of capital borrowed which was outstanding at March 31st, 1898.	Amount in sinking fund or loans fund at March 31st, 1898, in respect of capital borrowed.	Average annual income for the five years ended March 31st, 1898, or, if the undertaking commenced during that period, from date of commencement.	Average annual working expenses from the period mentioned in Column 7.	Average annual net profit for the same period.	Average annual amount paid during the same period in respect of principal and interest on capital borrowed.	Average annual amount set apart for depreciation.
	£	£	£	£	£	£	£	£	£	£
Gasworks	20,175,764	19,254,350	3,457,329	15,796,500	1,075,802	4,517,126	3,336,918	1,180,208	772,535	37,333
Tramways	3,215,654	2,689,384	499,377	2,190,007	104,969	435,942	302,670	133,392	90,705	8,488
Electric lighting	3,416,711	3,108,533	108,848	2,990,582	101,642	304,499	168,755	137,320	126,659	3,747

Names of boroughs and of the counties in which they are, or are deemed to be, situate.	Name of undertaking.	Date when Corporation commenced working.	Capital. Total capital, inclusive of borrowed capital provided by Corporation.	Capital. Amount of capital borrowed.	Capital. Amount of capital borrowed which has been paid off.	Capital. Balance of capital borrowed which was outstanding at March 31st, 1898.	Capital. Amount in sinking fund or loans fund at March 31st, 1898, in respect of capital borrowed.	Income. Average annual income for the five years ended March 31st, 1899, or if the undertaking commenced during that period, from date of commencement.	Income. Average annual working expenses for the period mentioned in column 9.	Income. Average annual net profit for the same period.	Income. Average annual amount paid during the same period in respect of principal and interest on capital borrowed.	Income. Average annual amount set apart for depreciation.	Mode in which average annual net profit has been applied.	Observations.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	
			£	£	£	£	£	£	£	£	£	£		
Tunbridge Wells	Electric lighting	1895	31,275	24,752	...	24,752	1,389	5,800	2,776	3,024	1,414	...	To payment of principal and interest. and towards reserve fund.	.....
Portsmouth ...	" "	1894	120,414	120,414	...	120,414	9,352	10,726	5,943	4,783	4,388	...	To liquidate debt for principal and interest during construction.	..... [present.
Southampton...	" "	1896	56,064	56,064	...	56,064	2,050	3,941	2,249	1,692	2,287	...	.....	The deficit is carried to suspense account at
Croydon ...	" "	...	...	...	...	...	...	...	...	...	...	...	.....	Taken over by the Corporation on March 31st, 1898. Loans to the amount of £37,400 have been raised for the purpose.
Kingston-upon-Thames	" "	1893	43,426	43,426	2,975	31,348	...	2,842	2,762	80	1,280	...	Towards payment of principal and interest.	Cols. 4, 5, 6, cover the period up to Sep. 1st, 1898. The averages shown in cols. 9 to 12 are calculated up to Dec. 31st, 1897.
Brighton ...	" "	1981	212,335	188,544	4,973	183,571	10,832	20,957	10,653	10,304	7,450	...	After payment of debt charges the balance was appropriated partly in aid of reserve fund and partly in aid of district rate.	Col. 5 represents the nominal value of the stock issued. The amounts actually received in respect of stock was £198,155. [begun in June, 1898.
Hastings ...	" "	...	6,947	6,947	300	6,647	396	...	...	...	...	...	.....	Col. 2.—For public lighting only, and was
Bedford ...	" "	1894	46,389	39,000	2,920	36,080	...	2'955	2,114	841	1 806	...	Towards payment of principal and interest.	This undertaking is in a better position than the figures show, owing to works being rapidly extended, and interest and instalments have to be paid before a single consumer is connected to the new mains.
West Ham ...	" "	...	...	...	...	...	...	...	...	...	...	...	.....	The Town Council have, since March 31st, 1898, undertaken electric lighting works, for which loans to the amount of £50,000 have
Great Yarmouth	" "	1895	33,795	33,795	300	33,495	2,039	3,165	2,347	818	1,401	...	.....	..... [been raised.
Exeter ...	" "	1896	13,981	13,981	...	13,981	...	4,044	2,821	1,223	1,018	...	Carried to reserve fund	.....
Torquay ...	" "	1898	...	...	...	...	...	...	...	...	...	...	.....	Col. 2.—Started March 17th, 1898. Loans to the amount of £22,300 have been raised.
Bath	" "	1897	50,378	32,834	...	32,834	600	7,273	5,321	1,952	707	...	Carried forward	The figures are made up to Dec. 31st, 1897.
Taunton ...	" "	1893	25,405	20,507	1,429	19,078	626	2,827	2,130	697	1,054	...	To payment of principal and interest.	.....
Bristol ...	" "	"	156,900	156,900	16,120	140,780	...	11,853	6,703	5,150	5,994	...	Part carried to reserve fund, the balance being carried forward.	.....
Cheltenham ...	" "	1895	67,852	47,485	...	47,485	2,012	2,299	2,067	232	1,303	...	.....	.....
Burton-upon-Trent	" "	1893	30,993	30,894	707	30,187	2,825	1,297	1,200	97	1,678	...	Towards payment of principal and interest.	..... [counts made up to Dec. 31st, 1897.
Hanley ...	" "	1894	51,634	51,634	...	51,634	2,586	4,964	3,019	1,945	2,006	...	.....	Deficit met out of general district rate. Ac-
Stafford ...	" "	1895	20,000	20,000	1,272	18,728	...	1,248	727	521	929	...	.....	.....
Walsall ...	" "	"	21,500	19,622	841	18,781	507	1,808	1,315	493	982	...	.....	Loss charged to general district rate. Col. 2. —Accounts of gas and electric lighting were made up to Dec. 31st in each year.
Wolverhampton	" "	"	41,782	32,660	345	32,315	3,561	4,232	2,538	1,694	1,841	...	.....	.....
Coventry ...	" "	"	33,695	33,325	789	32,536	777	1,602	1,570	32	839	...	.....	Deficiency met out of general district fund.
Worcester ...	" "	1894	67,293	59,877	...	59,877	5,145	4,768	3,436	1,332	3,027	...	.....	.....
Derby	" "	1893	65,984	60,734	4,451	56,283	1,772	5,338	4,422	916	2,160	...	.....	Deficiency charged to general district rate.
Leicester ...	" "	1894	42,748	42,748	400	42,348	3,341	4,028	2,171	1,857	2,151	...	.....	.....
Lincoln ...	" "	1897	20,650	9.737	...	9.737	...	...	...	...	...	...	.....	Col. 2.—Works in course of construction.

Names of boroughs and of the counties in which they are, or are deemed to be, situate.	Name of undertaking.	Date when Corporation commenced working.	Capital.					Income.					Mode in which average annual net profit has been applied.	Observations.
			Total capital, inclusive of borrowed capital provided by Corporation.	Amount of capital borrowed.	Amount of capital borrowed which has been paid off.	Balance of capital borrowed which was outstanding at March 31st, 1898.	Amount in sinking fund or loans fund at March 31st, 1898, in respect of capital borrowed.	Average annual income for the five years ended March 31st, 1898, or if the undertaking commenced during that period, from date of commencement.	Average annual working expenses for the period mentioned in column 9.	Average annual net profit for the same period.	Average annual amount paid during the same period in respect of principal and interest on capital borrowed.	Average annual amount set apart for depreciation.		
1	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14	
			£	£	£	£	£	£	£	£	£	£		
Nottingham ...	Electric lighting	1894	85,000	77,865	1,764	76,101	2,426	6,036	2,413	3,623	2,634	989	To formation of sinking and depreciation funds, and to payment of principal and interest.	.....
Birkenhead ...	„ „	1896	37,980	20,000	397	19,603	...	1,500	1,466	34	804	...	.....	Deficiency is met out of general district rate.
Chester ...	„ „	„	45,000	43,087	...	43,087	732	6,808	3,451	3,357	2,343	500	In payment of preliminary expenses.	.....
Blackburn ...	„ „	1895	46,000	46,000	2,700	43,300	13	3,626	2,279	1,347	1,868	...	.....	The deficiency remains against future profits.
Blackpool ...	„ „	1893	84,238	80,577	...	80,577	5,439	8,004	5,135	2,869	2,625	166	In aid of rates, &c.	.....
Bolton... ...	„ „	1894	108,222	60,000	3,929	56,071	...	4,544	2,312	2,232	2,367	306	Carried to the reserve fund.	.....
Burnley ...	„ „	1893	28,842	26,750	2,715	24,035	...	2,913	1,431	1,482	1,169	...	To payment of principal and interest and formation of reserve fund.	.....
Bury	„ „	1896	25,513	23,645	50	23,595	714	1,133	728	405	1,258	...	.....	.....
Lancaster ...	„ „	1893	24,680	24,680	...	24,680	857	2,422	1,759	663	749	...	In aid of rates.	.....
Liverpool ...	„ „	1896	525,291	500,000	...	500,000	13,874	56,161	20,777	35,384	22,874	...	To formation of reserve and renewal funds, the balance carried forward.	.....
Manchester ...	„ „	1893	357,617	350,000	24,305	325,695	1,615	39,853	18,521	21,332	11,267	...	In aid of rates, and the balance being carried to reserve fund.	.....
Nelson ...	„ „	„	10,459	10,152	1,116	9,036	...	1,281	593	688	550	...	Carried to district fund.	.....
Oldham ...	„ „	1894	46,650	46,650	2,000.	44,650	1,062	4,310	1,972	2,338	1,565	...	Carried to reserve fund.	.....
St. Helen's ...	„ „	1896	13,560	10,000	354	9,646	...	918	950	...	306	...	.....	.....
Salford ...	„ „	1895	46,270	46,270	...	46,270	4,289	1,728	2,603	..	2,370	...	.....	The deficiency is met out of district rate.
Southport ...	„ „	1894	60,904	58,760	3,010	55,770	74	4,758	2,584	2,174	2,058	...	In repayment of capital expenditure disallowed.	.....
Kingston-upon-Hull	„ „	1893	61,739	61,739	6,834	54,905	...	6,758	3,128	3,630	2,431	...	To payment of principal and interest	Col. 5.—Including £8,265 raised temporarily pending the issue of stock.
Bradford ...	„ „	1889	162,843	119,012	14,050	104,962	1,462	14,820	6,376	8,444	4,889	1,462	Net profits reserved to meet any deficiency which arises until fund reach one-tenth of the aggregate capital expenditure.	.....
Dewsbury ...	„ „	1894	25,000	25,000	600	24,400	1,723	2,572	1,650	922	1,258	...	Towards payment of principal and interest.	.....
Halifax ...	„ „	1895	56,322	52,165	3,289	48,676	...	2,538	1,870	668	1,568	...	Do. do.	The deficiency is met out of district fund.
Harrogate ...	„ „	1897	40,996	25,235	...	25,235	425	1,360	1,675	...	1,236	...	.....	.....
Huddersfield ...	„ „	1893	69,416	69,000	...	69,000	9,256	5,181	2,617	2,564	3,339	324	To payment of interest, to formation of sinking fund, and to meet depreciation contingencies.	The figures in respect of this undertaking relate to the period to Dec. 31st, 1897, that being the close of the financial year.
Morley ...	„ „	...	...	...	...	...	...	...	...	...	...	...	.....	Col. 2.—Started in March, 1898. Loans to the amount of £22,500 have been raised.
Wakefield ...	„ „	1897	16 038	16,000	...	16,000	515	74	428	...	541	...	.....	.....
Whitehaven ...	„ „	1893	19,004	19,004	1,263	17,741	792	2,581	1,482	1,099	1,006	...	To formation of sinking fund.	.....
South Shields ...	„ „	1896	41,272	38,213	...	38,213	1,605	2,441	2,296	145	1,820	..	.....	.....
Sunderland ...	„ „	1895	45,800	43,300	2,650	40,650	38	3,044	2,027	1,017	1,875	...	Towards payment of principal and interest.	.....
Monmouth ...	„ „	...	...	...	...	...	...	...	...	...	...	...	.....	Col. 2.—Not yet begun working. Loans to the amount of £8,115 have been raised.
Newport ...	„ „	1895	39,000	37,914	...	37,914	2,300	3,177	2,528	649	1,584	...	To payment of principal and interest	.....
Cardiff ...	„ „	1894	31.615	31.615	...	31.615	2,621	5.991	5,420	571	2.590	...	Do. do.	The deficiency is met out of the district rate.

ELECTRIC TRACTION AND ITS APPLICATION TO SUBURBAN AND METROPOLITAN RAILWAYS.*

By PHILIP DAWSON.

(*Continued from page* 529.)

Distance 2,000 Feet, to be Run Over in 75 Seconds, or at an approximate Average Speed of 16 Miles per Hour.

Time during which power applied in seconds.	Maximum speed attained in miles per hour.	Time during which brakes applied.	Average power consumption per ton in B.T. units.
7·5	25·75	10·0	0·035
12·5	26·00	10·5	0·036
16·5	26·25	11·5	0·038
24·5	27·15	12·5	0·0475
31·0	28·25	14·0	0·0480
39·0	30·50	17·0	0·0575
53·0	36·50	22·0	0·0840

Distance to be Run, 2,000 Feet.

Tractive effort per ton in lbs.	Maximum speed in miles per hour.	Time in seconds during which brakes applied.	Time in which 2,000 feet run.	Average speed in miles per hour.	Board of Trade units per ton mile.
...	62·5	41·0	41·0	33	0·300
300	53·0	34·0	52·0	26	0·196
150	46·0	26·0	58·0	23	0·160
100	40·0	24·5	67·5	20	0·130
65	34·0	22·0	82·0	17	0·100
45	27·5	15·0	98·0	13¾	0·075
35·6	23·0	12·0	127·0	10½	0·057
7·6	17·5	11·0	160·0	8	0·045

In an experiment with a train composed of one motor car and one trailer car, weighing 57 tons, with an average distance between stations of 4,280 feet, a maximum speed of 37 miles was attained, the average speed being 17 miles an hour, the power required being 0·067 Board of Trade units per ton mile.

From a comparison of the actual results obtained on the elevated electric railways of Chicago and on the Metropolitan and District line in London, we see that whereas the maximum speed of 25 miles an hour is obtained in 10 seconds with electric traction, it takes 33 seconds to do it with steam locomotives—and that whilst the electrically propelled train could do the distance of 1,880 feet in 66 seconds, with steam it would take 93 seconds, or nearly half as much time again. If in the case of electric traction the power is cut off the moment the maximum speed of 25 miles an hour is obtained, and the train allowed to coast before the brakes are put on, the distance considered would be done in 76 seconds. The steam-driven train even then would take more than 25 per cent. more time to do the same distance.

Having tried to show the advantages which electric traction possesses as regards the possibility of increasing the frequency of the trains without decreasing the factor of safety, namely, the distance between two trains, it may be advantageous to see how, from an economical standpoint of generating power, electricity is a cheaper method of operation than steam locomotion. An electrically-driven train only requires one man instead of two to drive it, and when the train is not running no power is consumed, and no coal or water wasted. Steam locomotives, it is well known, use but very little less coal and water when they are standing still than when they are running, and are much less economical, consuming, as they do in America, from 5 to 6 lbs. of coal per indicated horse-power. On main line English roads it is stated that 3 to 4 lbs. are consumed, and taking an average power of 400 horse-power per locomotive, and a train plus engine weighing 250 tons, at a speed of 40 miles an hour, we get at the most economical rate about 0·65 lbs. of coal per ton-mile, or compared to the electric power required by electric traction 13 lbs. of coal per Board of Trade unit required, which is enormous—under favourable conditions it would not take much over 3 lbs. of coal to give one Board of Trade unit at the switchboard. A properly-designed electric station with large units would probably never consume more than 2 lbs. of coal per indicated horse-power-hour, or 2·65 lbs. per kilowatt-hour at the switchboard, and engines of the size of 4,000 to 6,000 horse-power would be guaranteed to consume not more than 12 lbs. of steam per indicated horse-power-hour. A large station would fully justify a comparatively large initial expense in coal handling and stoking machinery, and the location of the station could be chosen so as to be most advantageously situated as regards both coal and water, the coal without being handled being taken from either the ship's hold or the railway truck, conveyed automatically to the coal stores, and from thence automatically to the fires, the ashes being conveyed away automatically as well. In such a station but very few men would be required, and the cost of power could be reduced below ½d. per Board of Trade unit, including expenses of every kind.

Comparing again the coal consumption per train mile on large English main line railways, which varies from 35 to 58 lbs. of coal per train mile, we get a coal consumption of from 0·146 to 2·32 lbs. per ton mile, corresponding to 28·12 to 46·4 lbs. per Board of Trade unit, required to be generated at the power house. The following results actually obtained with slow-speed Corliss type engines and standard American railway generators, may be of interest:—

Total coal consumed, Brooklyn City Railway Company, per Board of Trade unit, 3 lbs.

Total cost, everything included, of Board of Trade unit at switchboard, 00·5195 cents (about one farthing).

Cost of coal per unit, 0·2307 cents, about 0·166 of a penny; Union Traction Company, Philadelphia.

Poorest coal, 3½ lbs. consumed per Board of Trade unit at switchboard.

In another case cost of coal, 0·272 cents per Board of Trade unit at switchboard, about 0·186 pence.

Total cost of unit, all included, 0·591 cents, about 0·296 pence.

Coal consumption in another case with Corliss engine, average for one year, per indicated horse-power-hour, 1·65 to 1·76 lbs.

What good slow-speed Corliss engines, properly designed for railway work, compared to other engines' mean are shown by the fact that by such a change in a large American station the coal consumption was reduced from an average of 8·3 to 4·9 lbs. of coal per car mile.

From a series of figures obtained from the various Chicago electric overhead lines, from 0·16 to 0·135 Board of Trade units are required at the switchboard to drive the trains, the average speed of the trains being 13½ miles an hour, and the maximum speed obtained varying from 28 to 35 miles an hour.

The coal and water consumption, per Board of Trade unit, must necessarily be very low, the losses in the step-up and step-down transformers and in the transmission and rotary converters would not be very great, and it would be perfectly feasible to attain an efficiency of 60 per cent. at the motor terminals and of 50 per cent. on the power applied to the car axles. Large engines and large generators and converters are designed so as to take an overload of 25 per cent. for any period of time, and be capable of overloading 50 per cent. for a short time without injury, and by a selection of proper units a very large economy could be attained.

American rating.			H.P. imputed	Amperes (full load).		Full load.	Commercial efficiency.		
Poles.	Kw.	Speed. Revs. per minute.		500 volts	600 volts		75% load.	50% load.	25% load.
6	165	200	237	300	275	93½	93½	92½	89
6	225	200	321	410	375	94	93¾	93	89½
6	225	150	321	410	375	94	93¾	93	89½
6	225	120	321	410	375	94	93¾	93	89½
6	325	100	464	590	542	94	93¾	93	89½
6	325	150	464	590	542	94	93¾	93	89½
6	425	150	607	773	710	94	93¾	93	89½
8	425	120	607	773	710	94	93¾	93	89½
8	425	100	607	773	710	94	93¾	93	89½
8	425	80	607	773	710	94	93¾	93	89½
8	525	125	750	956	877	94	93¾	93	89½
10	525	100	750	956	877	94	93¾	93	89½
10	525	90	750	956	877	94	93¾	93	89½
10	525	75	750	956	877	94	93¾	93	89½
12	850	120	1,206	1,545	1,420	94½	94¼	93¾	90
12	850	100	1,206	1,545	1,420	94½	94¼	93¼	90
12	850	80	1,206	1,545	1,420	94½	94¼	93¾	90
12	1,050	80	1,482	1,910	1,755	95	94¾	94	90¼
12	1,200	80	1,698	2,180	2,000	95	94¾	94	90¼
16	1,600	75	2,230	2,910	2,670	95	94¾	94	90¼

Metropolitan Elevated, Chicago.

Length of street	36½ miles.
Average distance between stations	1,600 feet.
Time interval between consecutive trains	2½ minutes.
Average speed in miles per hour	13 miles.
Maximum speed	28 miles.
Total rated power of generating station	5,000 kilowatts.

South Side Elevated, Chicago.

Length of street	18½ miles.
Average distance between stations	1,720 feet.
Time interval between consecutive trains	1½ minutes.
Average speed in miles per hour	14 miles.
Maximum speed in miles per hour	26 miles.
Total rated power (4 units 800 kilowatts each) of generating station	3,200 kilowatts.

Lake Street Elevated, Chicago.

Length of line	15 miles.
Power of station	3,000 kilowatts.

North-Western Elevated, Chicago.

Length of line	15 miles.
Rated power of station ... {3–1,500 kilowatts. 1–800 kilowatts.}	5,300 kilowatts.

* Society of Arts, March 22nd.

Loop, Chicago.

Length	4 miles.
Rated capacity of station ... { 4 units / 1,500 kilowatts }	6,000 kilowatts.
Number of trains passing over line in 24 hours ...	3,000 trains.
Total rated power of Chicago elevated lines, approximately	22,500 kilowatts.

Nantasket Beach.

Length of line	20 miles.
Rated power of station	1,800 kilowatts.
Average distance between stations	4,280 feet.
Maximum speed per hour	43 miles.
Average speed	25 „
Board of Trade units per ton-mile, at switchboard..	0·0808
Weight of two-car train	55 tons.

The elevated railroads of New York and Brooklyn have been losing business during the last few years so rapidly that the financial condition of the Brooklyn system is serious, and the return on investment of the New York system much reduced, and is still declining. The elevated railroads of Chicago have never been able to earn a satisfactory dividend. The general introduction of electricity in the Chicago system has greatly improved the Chicago situation, in

Approx. weight of armature and commutator.	Approx. weight of generator complete.	Diameter of shaft in inches.	English rating at 500 volts constant potential. Classification.	Amperes full load.	Approx. H.P. to drive.	Approx. weight of steam engine in lbs.
6,000	13,100	9	150–200	3·0	212	42,500
7,000	21,000	9–10½	200–180	400	285	50,000
13,900	34,300	9–11½	200–135	400	285	55,000
14,520	37,000	9–11½	200–110	400	285	85,000
17,000	45,500	9–11½	300–135	600	428	144,000
21,000	61,000	11½–14	300– 90	600	428	85,000
25,500	60,000	14–16	385–135	770	550	94,000
29,000	65,000	14–16	385–110	770	550	100,000
31,000	72,000	15–18	385– 90	770	550	180,000
32,000	75,000	15–18	385– 75	770	550	198,000
31,000	72,000	16–18	480–115	960	685	181,000
27,000	69,000	16–18	480– 90	960	685	187,000
32,500	76,600	16–18	480– 80	960	685	192,000
36,000	87,000	16–18	480– 70	960	685	198,000
40,000	100,000	19–22	800–110	1,600	1,135	215,000
44,000	107,000	19–22	800– 90	1,600	1,135	237,000
47,000	116,000	19–22	800– 75	1,600	1,135	285,000
55,000	130,000	22–25	950– 75	1,900	1,341	300,000
68,000	158,000	24–27	1,100– 75	2,200	1,553	415,000
70,000	160,000	24–27	1,500– 70	3,000	2,120	460,000

spite of the competition of the surface trolley lines, which parallel the elevated lines in most cases. The elevated railroad problem is resolved into a discussion of speeds, station frequencies, and relative costs of service. Any railroad of this class which aims to maintain a high schedule must choose a motive power in which the possibilities of rapid acceleration are a maximum, and—all other conditions being equal—should choose that particular motive power which will bring about the quickest acceleration, consistent with due economy.

The Manhattan system is a comparatively simple one, with four main through lines, without branches of importance, while the Brooklyn and Chicago systems are composed of trunk lines with branches, involving more or less complicated switching arrangements. Until about a year ago, the three Chicago companies, the Lake Street, the South Side, and the Metropolitan, had independent termini in the business heart of the city. Now, however, the newly constructed "loop," encircling the business district, is used as a terminus for all three lines and for a fourth, the North-Western, now under construction, and all the elevated trains of the city pass round this loop on each trip. The Brooklyn elevated system has lately secured a new terminus on the Manhattan Island side of the Brooklyn Bridge, and experiments are being made with a view to converting the entire Brooklyn system to electricity in the near future. The entire New York system, however, is at present operated by steam locomotives.

The little locomotives in use on the New York system weigh 47,000 lbs., of which 31,500 are on the four 42-inch driving wheels, and 15,500 are on the four 30-inch truck wheels. The total wheel base is 193 inches, of which 60 inches is rigid. The cylinders are 12 inches in diameter, and have a 16-inch stroke. The grate area is 16·5 square feet, and the total heating surface is 4,034 square feet. There are 154 flues 1½ inches in diameter and 75 inches long.

The Standard Manhattan car weighs 29,088 lbs., has seats for 48, and frequently carries 100 passengers. It is mounted on eight 30-inch wheels.

The total weight of a five-car loaded Manhattan train is about 130 tons. The weight on the drivers is 12 per cent. of the total train weight, and with 25 per cent. adhesion, the maximum drawbar pull possible for the locomotive to exert is 7,875 lbs.

The electric locomotive car of the Metropolitan Elevated Railway Company, of Chicago, weighs 53,200 lbs. complete with motors, or 40,000 lbs. exclusive of motors. It is a standard American passenger car with full seating capacity, about one-half of each platform being taken up with the cab and necessary controlling apparatus. The trail cars weigh 33,000 lbs. The seating and standing capacity of both motor end trail cars is approximately 90 passengers. The average four-car heavily loaded-train will weigh about 100 tons, of which 32·5 tons approximately are on the four wheels of the locomotive's motor trunk, and 67·5 tons are in the trail cars. From 30 to 35 per cent. of the entire train weight is available for traction under these conditions, and the maximum drawbar pull possible to exert without slipping of wheels is about 16,250 lbs.

The South Side Elevated Railway Company, of Chicago, is equipped with the Sprague multiple unit system, by means of which two or more cars in a train are equipped with motors and may be operated in unison by a single controller from any point in the train. The company is now operating four-car trains, on each of which is a motor truck carrying two motors. The cars weigh about 20 tons each without load, and about 60 per cent. of the train weight is available for traction.

(To be continued.)

PHYSICAL SOCIETY.

Ordinary Meeting, March 24th, 1899.

Prof. Oliver Lodge, F.R.S., President, in the Chair.

Mr. W. R. Cooper read a paper by Mr. A. P. Trotter on "The Minor Variations of the Clark Cell."

The author describes a series of experiments in which he compared the E.M.Fs. of certain standard cells at frequent intervals from July, 1896, to February, 1897, at Cape Town, where the temperature of the double box containing the cells varied between the limits 13° C. and 28° C. One cell was selected for comparison with all the others. No special precautions seem to have been taken to keep the temperature of this selected cell constant. The observed differences between the E.M.Fs. of the respective cells rarely exceeded 0·001, corresponding to about ¼-inch on the slide-wire of the potentiometer. Details as to the area of the slider-contact are not stated; the readings were generally taken to the fourth decimal, *i.e.*, to one-tenth of a millivolt, and occasionally to one-fourth of this. Temperature was read to 0·1° C. on a mercury thermometer placed through a hole in the double box containing the cells—not in the cells themselves.

Mr. E. H. Griffiths said that the paper appeared to have value only in so far as it showed that Clark cells at Cape Town behaved in a manner that agreed with common knowledge and general experience everywhere else. Their variations depended upon shifts of temperature, and the consequent changes in the degree of saturation of the liquid. From his own experiments during seven years upon 42 Clark cells he had shown that if temperature was kept constant to within 0·01° C., the steadiness and uniformity of all the E.M.Fs. was most remarkable. They started with discrepancies, but at the end of the time it was impossible to detect any differences. It was of little use to put a thermometer anywhere but within the cells; very slight changes of temperature caused serious changes in the degree of saturation of the liquid. The existence of the capricious lag of E.M.F. behind temperature precluded the possibility of formulating a temperature correction for Clark cells. In the case of Callender cells there was no lag; their E.M.F. varied slightly with temperature, by a definite amount, which could be corrected by a coefficient.

Mr. W. R. Cooper said the method of comparison used by the author was unsuitable, because to arrive at the differences of E.M.F. necessitated the measurement of the E.M.F. of each cell. The variations only amounted to a few ten-thousandths of a volt. The length of potentiometer wire corresponding to a thousandth of a volt, was only a quarter-of-an-inch; under such conditions it would be difficult to ensure accuracy. A method of opposition would have been preferable. Mr. Cooper had found that Board of Trade cells only vary about one ten-thousandth of a volt between themselves from day to day. Cells of the H form vary about one-fifth of that amount.

Prof. J. D. Everett then read a paper by Dr. E. H. Barton and Mr. W. B. Morton on "The Criterion for the Oscillatory Discharge of a Condenser."

The object of the paper is to inquire how the condition for the oscillatory discharge of a condenser is modified when the ordinary differential equation of the second degree is supplemented by the terms added by Maxwell to take account of the distribution of current in the (straight) wire. The coefficients of these terms are relatively small, so that the algebraic equation giving the periods is a quadratic with small terms of higher order added. The effect of these higher terms is, first, to introduce very rapid vibrations of small amplitude; and, next, to displace the roots of the unaltered quadratic. The nature of the discharge—oscillatory or non-oscillatory—may be taken to be determined by these principal roots, and the critical case is when they are equal. The condition for equality is obtained, by the property of the derived function, as a series of powers of the small coefficients of the equation, which may be carried by successive approximation as far as is desired. The paper also treats the question by an alternative, and more physical method, which consists in replacing the resistance, inductance, and capacity, that occur in the ordinary formula, by modified values. This gives the criterion correct to the third order in the small terms. It is shown that a condenser satisfying the critical condition on the simple formula would, when the added terms are taken into account, give an oscillatory discharge.

Prof. Lodge said that the result naturally to be expected of "throttling," viz., the increase of resistance, and decrease of self-

induction, due to the current keeping to the outside of the conductor would tend rather to damp out the oscillations than to favour them.

Prof. Everett observed that the equation was no longer a quadratic, and that the quadratic criterion as to whether the discharge was oscillatory or non-oscillatory did not hold. The paper appeared to be consistent with itself, and he considered that the authors had satisfactorily proved, in their discussion of the equation of the current, that the effect of "throttling" was to *increase* the tendency towards the oscillatory mode of discharge.

Prof. Lodge admitted that the quadratic criterion did not hold; he thought it most likely that the authors, who evidently had gone into the matter with care, were right. At the same time he wished to call attention to the singular and unexpected character of their conclusion. If it turned out that it was correct, *i.e.*, that there was no slip in sign, it was a result upon which he would desire to congratulate them.

The President proposed votes of thanks, and the meeting adjourned until April 21st.

DYNAMO AND ENGINE CAPACITIES.

The best results from a plant, says Mr. A. D. Adams in the *Engineer* (New York), are only secured when the engine bears a correct ratio to the dynamo, and what this ratio is depends very much on the load curve, or hours of light and full load. Obviously the longer the full load hours the larger will be the most economical engine, but when hours of light load are numerous the engine must be small, and must run the heavily loaded hours at less economical rates of expansion. For the average conditions under which an engine of high-speed automatic type is found working a curve is given on the basis of 25 lbs. of steam at full rated load; at quarter load the engine absorbs 40 lbs. of steam per H.P.-hour; at half load only 30 lbs.; at three-fourths load the consumption is about 26¼ lbs., and the same at one and a quarter load. Such an engine can thus work well over a range from 1 to 1·667 at very little difference of economy, the load 1·33 being the best point of unity—that is, the load may fall off 25 per cent. or rise 25 per cent. at a trifling extra cost of fuel, but beyond these ranges above and below most economical point the curve rises more and more steeply. Therefore the best load at which an engine should be proportioned is that which has the maximum value for the product H.P. × hours.

In isolated plants the average load over the most hours is about 25 per cent. The maximum load endures only one-eighth or one-fourth of the entire run. Division of units cannot be carried too far as it will defeat its own aim. But where the power is large enough to admit of several units it is easy to add or subtract a unit as the load varies, a fresh unit being put on as the first one of a pair passes its full load (as regards engine) by 25 per cent. We have then two units each five-eights loaded. When a third is put in there will be three units each at nearly seven-eighths full load, and so on. Thus having sub-divided into as many units as a case warrants, the next expedient is to drive each dynamo with the smallest engine which will operate it at maximum load. The typical load curve shows that overload continues for a fraction of the time run at underload, and thus while wasteful for a short time it does not become so wasteful at an underload as it would do if proportioned for economy at full load.

As illustrative of this assume a plant of 1,000 lamps of 16-C.P., with a minimum load of one-fourth maximum. At 60 watts per lamp including line loss, the dynamo must have 60 kw. capacity. There will be two 30-kw. dynamos, which will have a 90 per cent. efficiency at full load. The total mechanical power per unit must be 33,333 watts, or 44·7 H.P. Assume a load for the engine of 20 per cent. beyond its best. Then the engine must give 37·25 H.P. at best efficiency. Add 10 per cent. for friction, and 40·97 H.P. appears. At one-fourth the lamps the engine will be called on for 22·35 H.P. Adding the 10 per cent. constant of 372, we find 26·07 H.P., which is more than 60 per cent. of the rated engine capacity of 41 H.P., so that the consumption of steam should not exceed 27 lbs. at quarter load, and will diminish as the load gets up to full. If, however, the engine had been selected 20 per cent. too large for full load, it would, as above, have been 61½ H.P. size, and at quarter load, or 27·95 including the 10 per cent. for engine friction, it would only have been working to 46 per cent. of its rated power, and the steam consumption would have been 32 lbs. per H.P. hour in place of 27 lbs. for the small engine. There is also the additional loss of the 2 H.P. for the extra friction of the larger engine, not to name first cost, maintenance, interest, &c.

THE "TERRIBLE'S" BOILERS.

We ventured some months since to criticise the wisdom of such large scales of experiment as was exemplified in the fitting of our cruisers, *Powerful* and *Terrible*, with Belleville boilers. The recent explosion on the *Terrible*, if it does not justify our criticism does at least justify the assertion of the late L. E. Fletcher, of the Manchester Steam Users' Association, that the safety boiler—a water-tube boiler of some 20 years ago—did not deserve its title. A quarter of a century of experience in water-tube boilers leaves us still at the same point. Water-tube boilers may not kill in batches of 10 at a time and so draw the attention of the civilised world to their danger, but they explode in detail, and kill or maim an odd stoker, and the disaster which is serious at least to the odd man or his belongings does not attract a tenth of the notice centre on a shell boiler explosion which kills four men and wrecks a cottage or an outhouse. Details are not to hand as to the *Terrible*, but with her sister failure, the *Powerful*, there seems to be a good deal of doubt as to their future.

The Belleville boiler is said to be universal, or nearly so, in the French Navy. Now that trouble seems to be over with our neighbours we feel inclined to be a bit sorry for the fact, but is it not possible that we ought of late to have been glad it was so, though not sufficiently glad to wish to follow their example? There appears altogether too much care and attention needed for the Belleville boiler. We cannot understand any engineer feeling safe with such flatly inclined tubes over fierce fires. It would be dangerous enough on an even keel, such as a concrete floor, but on board ship, with a list to port or starboard, such as may any time occur, the reversal of the inclination of the tubes cannot be good.

We suppose the very flat angle of the tubes is due to the desire to save height. Other water-tube boilers which have tubes much more steeply inclined occupy a considerable height, and the same amount of surface cannot be got into the same space. Lovers of water-tube boilers seem never so happy as when they can demonstrate the large area of heating surface crowded into a few cubic feet of space. The quality of the heating surface, or its influence upon combustion, has very little weight with them. Their one idea is to get up a fire and cool it down as rapidly as possible by means of the coldest possible surfaces. If the fuel will not burn, then so much the worse for the fuel. Other fuel at double the price must be used, but the principle of the boiler must not be impugned.

Water-tube boilers have had a magnificent opportunity of distinguishing themselves by sea and land. At sea the boiler of small curved or steeply inclined straight tubes appears to have done well, and established itself within a limited sphere—that of the torpedo and similar craft. But neither by land or sea have large water-tubes shown the qualities essential to a permanent success. Neither in economy have they beaten shell boilers, nor in elasticity of work, nor in wide range of either their water supply or fuel, and if they are to continue in any sort of favour, their designers must give a more close attention to these matters. It is not sufficient that objections be met by charges of fossilism. An engineer is not necessarily a fossil because he does not plump for water-tube boilers. We expressed doubts as to the Belleville boiler, and it would seem our fears were not altogether groundless. We wish they had been. The country at large will wish the same, while demanding at the same time some satisfactory reason, if there be such, for the *Terrible* explosion.

Our heavy contemporaries accepted the water-tube boiler as a finality and a magnificent success on a very full-manned trial trip. We did not so accept it, and we still assert that the experiment was on too huge a scale. England cannot afford to play skittles with her Navy. How much of the Chinese trouble was due to faults of the *Powerful* on the Chinese station we may, perhaps, never know, but we may surmise she was a factor in the vacillating policy of the Government.

THE EQUIVALENT OF A HORSE-POWER.

A useful table is published in the *Engineer* which gives the equivalent in different units of the horse-power. As understood by engineers, the horse-power is not a definite quantity. It is usual to hear the term used as though it were. The horse-power is a rate of doing work, and was fixed by Watt as that rate of doing work which would raise a load of 33,000 lbs. one foot in one minute. For human purposes the horse-power is a fixed rate. Actually, as the year is varying slowly in length, the horse-power of a million years hence will be a trifle different. It is said that Watt fixed upon the curious number 33,000 as being simply about 50 per cent. above the average rate of work of London dray horses, whereby his customers could not complain at any shortcomings of his engines. As steam pressures advanced it became recognised that a nominal 60-horse engine could be called upon to indicate about 300 H.P., and the term has been much misused. As a matter of fact, however, there can be only one really recognised horse-power. Thus a steam engine will indicate 100 horse-power, but its brake horse-power is, say, 90 only. The 10 H.P. has simply been absorbed by internal friction, and to some extent, so far as piston and valve friction is concerned, has been exerted upon the steam and has helped to dry it. An engine uses less steam, in fact, than it would do if it indicated 100 H.P. and had frictionless pistons. In all problems of mechanical engineering it is often necessary to correlate our units. The table given by the *Engineer* does this at three different values, the horse-power minute, the horse-power second, and the horse-power-hour. Steam engineers mix up their units somewhat, and are apt to confuse the lay mind. Thus they speak of the horse-power in a general sense on its minute basis, but they say an engine requires 20 lbs. of water per hour. They mean by this that for each horse-power-minute, or 33,000 foot-pounds per minute which it exerts, it will consume 20 lbs. of steam if allowed to continue that rate of work for 60 minutes.

Similarly engineers refer to coal consumption at an hourly rate per square foot of grate surface. But a horse-power-hour must not be taken as 33,000 foot-pounds per hour. It is 33,000 foot-pounds per minute performed 60 times in succession.

It is a little unfortunate that electrical engineers should have introduced new units. The product of the volt and ampere they call a watt, which is only a very small fraction of the steam engineer's idea of what might be termed a watt. Then the electrical engineer's kilowatt is more than a horse-power.

To prevent error, it should be stated that the value of the kilogramme metre is given in terms of the Continental horse-power, which is $1\frac{3}{4}$ per cent. less than the English horse-power, being only 32,550 foot-pounds per minute.

The very common method of reducing all expressions of energy to foot-pounds in order to find their relative values may be avoided by this table, which gives the necessary factor for direct conversion. For approximate work graphic tables of "curves" are convenient for use in these matters, and engineers who have much of this kind of work to do should construct their own diagrams on squared paper.

In terms of	Per hour.	Per minute.	Per second.
Mile tons	$0{\cdot}1674 = \frac{1}{6}$	0 00279	$46{\cdot}5 \div 10^6$
„ lbs.	$375 = \frac{3}{8} \times 10^3$	$6\ 25 = \frac{1}{16}$	$1{\cdot}104 = \frac{1}{10}$
Foot tons	884	14·73	$0{\cdot}2455 = \frac{1}{4}$
„ lbs.	$1{\cdot}98 \times 10^6$	33×10^3	550
Inch tons	$10{\cdot}61 \times 10^3$	176 8	2 946
„ lbs.	$23{\cdot}76 \times 10^6$	$0{\cdot}396 \times 10^6$	0 0066
Kilogramme-metres ...	270×10^3	4,500	75
Cubic feet water × feet of fall	31,731	528 8	8 813
Gallons × lb. pressure per square inch ...	85,800	1,430	23·83
Cubic feet flow × lb. pressure per sq. in. ...	13,750	$229\frac{1}{6}$	3 82
Cubic feet flow × inches of water gauge ...	$0\ 38 \times 10^6$	6 346	$105\frac{5}{6}$
Lbs. F. degree heat units	2,545	43·42	0 707
Kilogramme C. degree heat units	632·55	10·54	0·1757
Lbs. steam from and at 212° F.	2·63	0 0438	$0{\cdot}73 \times 10^3$
Fuel burnt in lbs. at 14,000 heat units per lb.	0 1818	$3{\cdot}03 \div 10^3$	$50{\cdot}5 \div 10^6$
Fuel burnt in lbs. at 12,725 heat units per lb.	0 20	$3{\cdot}3 \div 10^3$	$5{\cdot}5 \div 10^6$
Gas burned, cubic feet at 636 units per cube foot	4	$\frac{1}{15}$	$\frac{1}{900}$
Producer gas, cubic feet at 127 units per cube foot	20	$\frac{1}{3}$	$\frac{1}{180}$
Joules = watt-secs. = 10^7 ergs.	$2{\cdot}68 \times 10^6$	44·760	$746 = \frac{3}{4}$ kw.-sec.

ELECTRIC LIGHTING IN THE CITY.

(*Continued from page* 499.)

The inquiry was resumed by Sir Courtenay Boyle on Tuesday last week at the Guildhall.

Mr. Watkinson, accountant, of the Deutscher Bank, said that the supply of the City of London Electric Lighting Company at present was most unsatisfactory, unreliable and deficient especially in foggy weather when sometimes it failed altogether. The bank had made complaints to the company but had obtained no redress. His opinion was that competition in electric lighting in the City would be a great benefit to the citizens.

Similar evidence was given by Mr. M. Batten, of the Equitable Insurance Company, of New York, Mr. Spence, of the Poultry, Mr. Edwards, chief clerk of the offices of the Pacific Railways, and Mr. H. G. Wheatley.

Mr. Patchell, the chief engineer of the Charing Cross and Strand Electric Supply Corporation was recalled, and in answer to Mr. Shiress Will, said the company had at their Lambeth and Maiden Lane stations a capacity to hang 210,000 8-candle lamps. They had so far actually hung 142,000 lamps, and were prepared by Christmas to increase their capacity to 360,000. With regard to the City of London Company's charges, it would be necessary for a consumer to get the charge down to 4·4d. per unit to burn the lamps during the whole 24 hours.

Replying to Mr. Cripps (for the City of London Company) he said that last year his company increased 26,694 lamps. The time of day of their maximum load varied between winter and summer. In winter it was about 5 o'clock, and in summer about 8 o'clock. The expensive thing in the production of electricity was to have a heavy load for a very short time and a smaller demand for the rest of the time, and they in common with other companies experienced that difficulty. He doubted whether the City Company was in a more difficult position in that respect than his own company.

Mr. Cripps: Is it not a fact that the supply of the City of London Company was confined to the City in order that the area might have the benefit of the whole output?—Every electric lighting company has its area.

But is it not a fact that your capacity at Lambeth and Maiden Lane is not more than sufficient for the prospective needs of the Strand District?—There is a good reserve there, but, of course, if we were to supply the City, it would be necessary to have a separate and distinct generating station ultimately.

In further answer to Mr. Cripps, Witness said his company had made a very good living out of their operations. In the Charing Cross area there were three competing companies.

Sir Courtenay Boyle: Allowing for the growth of St. Giles and Holborn, will not your margin of 68,000 lamps be eaten up very rapidly?—At last year's rate it would be about 28,000, but we have further plant coming in which would run out to about 48,000.

You contemplate the possibility of acquiring a new generating station. Have you any estimate of the amount of supply it would produce?—We should require a plant of 15,000 horse-power for the City in the proposed new generating station, and this would supply 300,000 lamps to the City.

At this point Mr. Brooke-Hitching, C.C., asked to be allowed to give evidence as an independent witness.

Sir Courtenay Boyle said he could not refuse to hear Mr. Hitching if he deliberately made the request, but Mr. Hitching must remember that he was a member of the City Corporation.

Mr. Brooke-Hitching said he had not lost sight of that.

Mr. Pope, Q.C. (City of London Electric Lighting Company), said he understood that Mr. Hitching was not called by the Corporation or any company.

No further objection being taken, Mr. Brooke-Hitching proceeded to state that he was a member of the City Corporation, the Metropolitan Asylums Board, the Marylebone Board of Guardians, and the Marylebone Vestry, and also with other bodies who were large consumers of electric light. He was also connected with a large business which had branches in different parts of London where electric light supplied by various companies was used. He was not a shareholder in any of the companies who were applying for provisional orders that day, nor had he been asked by anyone to appear as a witness. Comparing the quality of the services of the City of London Electric Lighting Company with those of the Metropolitan Company, the Westminster Company and the Kensington and Knightsbridge Company, he had no more complaints to make of the City Company's supply than of the supplies of other companies. His opinion was that a great deal of defective lighting was due to the omission of consumers to change their lamps with sufficient frequency.

Witness was proceeding to go into the question of the right of the Corporation to purchase, but Sir C. Boyle said he could not allow him to discuss that subject.

Mr. Hitching said the question had an important bearing on the question of competition.

Sir C. Boyle: What we want to know is if you as a citizen think it desirable that there should be competition in electric lighting in the City.

Witness said he was in favour of reasonable competition, but he believed the entry of one other company into the City would mean exploiting the pockets of the public and getting money therefrom. As far as the policy of the City of London Electric Lighting Company was concerned, he thought they should have been more progressive and have reduced prices, and if they had fitted up a large station and charged less he considered they would have been in a better position now. He did not believe that if a provisional order was granted to either of the three companies that competition would result. His experience was that it was impossible to get better terms from one company than another. Facilities ought to be given for one company to buy current from another. He believed that if there were competing orders given it would result in the streets being torn up, but that the citizens would not get their light at a lower price than now, and he was strongly opposed to the streets being torn up for the benefit of any company whatever. There was no doubt that the condition of the City was very different from other areas, because there was little going on, and there was no demand for the light. There were no theatres, and the licensed houses were nearly empty. The load was a day load. He believed that if two or three companies were to come into the City, there would be some *sub rosa* agreement to keep the prices at one level, and benefit the shareholders to the disadvantage of the ratepayers and consumers, and he trusted that the Board of Trade would refuse to grant any order unless competition could be reasonably assured.

Sir Courtenay Boyle: Have you any complaint to make as to the inefficiency of the electric lighting of the City?—Yes, and I do so of every company in London.

Replying to Mr. Balfour Browne, the Witness said the business he was connected with was that of baby carriage manufacturers to the Royal Family.

Mr. Balfour Browne: These should be good customers I should say.

The case of the Charing Cross and Strand Company was then stated by Mr. Will to be closed.

Mr. Fitzgerald then addressed Sir Courtenay Boyle for the Metropolitan Electric Supply Company, and stated that the present share capital was £1,000,000, and they had power to issue debenture capital to the same amount. At present £850,000 was issued and £743,530 paid up. Debenture stock to the amount of £220,000 had been issued, so that the total paid up capital was £963,530. The credit of the company was excellent for the £10 shares stood at £18, and the company could execute any powers which might be conferred upon it. The company had five generating stations and in addition last year acquired Parliamentary powers to obtain a large area at Willesden, where a large station would be erected, and they would then be in a position to supply the City of London on most favourable and economical terms. If they got the order they would give a supply on the

continuous current system through a high pressure main of 10,000 voltage from Willesden to a transforming station in the City. With regard to the company entering into effective competition with the City of London Company there could be no doubt about that, because the company's maximum price at present was lower than that of the City Company. Of the three companies asking for orders, he contended that the Metropolitan Company was the strongest, and, by reason of its large station at Willesden, would be in a position to supply current to the City before any of the other companies.

Mr. E. C. Owen, secretary of the Metropolitan Company, was called, and gave evidence in support of the statement of counsel.

Replying to Mr. Will, Witness said it was true that at present they had been unable to meet all their demands, and had taken current from the City of London Company and the London Electric Supply Company.

By Mr. Cripps: They had powers in St. Marylebone parish, but they would not look upon it as a piratical action if another company tried to get in. They had an agreement with the Vestry of Marylebone. Of course they would not welcome competition in Marylebone and would fight against it.

Mr. Cripps: What is the difference between what you are proposing to do with regard to the City of London Company and what another company might do in Marylebone?—I do not think there is any difference.

What do you say to a company coming from outside to compete with a company bound not to go outside the City?—The City of London Company might consider it unfair.

I will ask you frankly. Don't you think it very unfair?—I think it might be considered unfair from your point of view.

But don't you consider it very unfair?—If I were in the position of the City of London Company I should certainly think it unfair.

But don't you yourself think it unfair?—I have not looked at it from that point of view.

Well, I put the proposition to you now?—Yes, I think it is unfair up to that point.

The Clerk to St. Bartholomew's Hospital was then called, and said that the board of the hospital wished to have electric light, but the price at present was prohibitive.

Evidence of a similar character having been called, the case for the Metropolitan was closed.

Mr. J. C. Bull, secretary of the City of London Electric Supply Company, in reply to Mr. Cripps, said there had been a continuous increase of consumers supplied by his company. The present number was 7,700. Generally speaking, they received very few complaints, and in nine cases out of ten it was found that the fault lay with the consumer in burning his lamp too long. He should say that the financial condition of the company was stronger than that of any other electric lighting concern.

Replying to Mr. Will, Witness said the demand on the company for the supply of electricity was restricted practically to five days in the week, for a very short time in the evening, for about five months out of the 12.

Mr. Bailey, the engineer of the company, said he believed the companies who wanted orders were in ignorance of the conditions prevailing in the City when they agreed not to charge more than 5d. per unit.

Replying to Mr. Pope, Witness said that although he considered the company well equipped against competition, yet the introduction of a new company would handicap it in its operation.

The inquiry was then adjourned till Tuesday, April 11th.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1899.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

5,968. "Controlling moving bodies by wireless telegraphy." A. A. Govan, J. Trotter and W. Jamieson. Dated March 20th.

5,975. "An improvement connected with magnetising machines for extracting iron and steel particles from borings and turnings, &c., of brass, copper and other non-magnetic metals, also from charcoal and earths." F. B. Parkinson. Dated March 20th.

6,002. "Receiving apparatus for so-called Hertzian waves for transcribing same into perceptible signs." J. C. Schaefer, E. Renz and P. Lippold. Dated March 20th. (*Complete.*)

6,016. "Improvements in or relating to electricity meters or indicators." P. Rissler and H. Bauer. Dated March 20th.

6,024. "Improvements in and relating to electrical incandescence lamps." V. I. Feeny. (Allgemeine Elektricitäts Gesellschaft, Germany.) Dated March 20th. (*Complete.*)

6,025. "Improvements in and relating to electrical incandescence lamps." V. I. Feeny. (Allgemeine Elektricitäts Gesellschaft, Germany.) Dated March 20th. (*Complete.*)

6,026. "Improvements in and relating to electrical incandescence lamps." V. I. Feeny. (Allgemeine Elektricitäts Gesellschaft, Germany.) Dated March 20th. (*Complete.*)

6,027. "Process for regulating the supply current for illuminating bodies or filaments composed of second-class conductors (electrolytes)." V. I. Feeny. (Allgemeine Elektricitäts Gesellschaft, Germany.) Dated March 20th. (*Complete.*)

6,028. "Process for the production of electrical resistances with small heating capacity." V. I. Feeny. (Allgemeine Elektricitäts Gesellschaft, Germany.) Dated March 20th. (*Complete.*)

6,032. "Improvements in or relating to electricity registers or meters." C. R. Loubery, E. Francois and H. Kunkelmann. Dated March 20th.

6,038. "Improvements in controlling switches and apparatus for electric motors." R. Hutchinson. Dated March 20th. (*Complete.*)

6,052. "Improvements in apparatus for working railway points and signals by electricity." F. W. Webb and A. M. Thompson. Dated March 20th.

6,053. "Improvements in electric lamps." S. Berditschewsky-Apostoloff. Dated March 20th.

5,054. "Improvements in electric lamps." S. Berditschewsky-Apostoloff. Dated March 20th.

6,061. "An improved process of and apparatus for electrically heating, compact or pulverised substances difficult to fuse, or infusible." W. Borchers. Dated March 20th. (*Complete.*)

6,064. "Improvements in electric relays." W. L. Wise. (A. C. Crehore and G. O. Squirer, United States.) Dated March 20th.

6,067. "An improved electrical drying apparatus for treating textile fabrics." J. M. J. Vignon-Danto. Dated March 20th. (*Complete.*)

6,125. "Improvements in electrically operated motor road vehicles, a part of the invention being applicable to secondary batteries, and to their charging connections and the connections of same with their motors." P. M. Justice. (The Pope Manufacturing Company, United States.) Dated March 21st. (*Complete.*)

6,129. "Improvements in or relating to electric batteries." C. Levetus. Dated March 21st.

6,142. "Improvements in telephonic exchange apparatus." A. E. Lamkin and J. G. Lemon. Dated March 21st.

6,149. "Improvements in the manufacture of filaments for incandescing electric lamps, and in means applicable for use in such manufacture." W. L. Voelker. Dated March 21st.

6,157. "Improvements in electric arc lamps." W. C. Johnson and A. Wundeblich. Dated March 21st. (*Complete.*)

6,159 "Improvements in or relating to facsimile telegraph apparatus." A. J. Boult. (W. P. Dunlany, United States.) Dated March 21st.

6,160. "Improvements in or relating to facsimile telegraph apparatus. A. J. Boult. (W. P. Dunlany, United States.) Dated March 31st.

6,213. "Improvements in insulating lining for electrical apparatus and process of making same." The British Thomson-Houston Company, Limited. (G. B. Painter, United States.) Dated March 22nd. (*Complete.*)

6,220. "Improvements in electrical incandescence lamps." Siemens Bros. & Company, Limited. (Siemens & Halske Aktien Gesellschaft, Germany.) Dated March 22nd.

6,229. "Improvements in column printing telegraphic instruments." F. H. W. Higgins. Dated March 22nd.

6,250. "Improvements in electrically illuminated advertising devices." C. Baker and W. A. Chatworthy. Dated March 22nd.

6,258. "Imitation cover for electric glow lamps." M. P. McInnerny. Dated March 23rd.

6,269. "Improvements in electric lampholders." R. F. Hall. Dated March 23rd. (*Complete.*)

6,270. "Improvements in combined electrical switches and lampholders." R. F. Hall. Dated March 23rd. (*Complete.*)

6,271. "Improvements in electric switches." A. J. McGeoch. Dated March 23rd.

6,296. "An improvement in telephone systems." J. C. Slater. Dated March 23rd. (*Complete.*)

6,297. "Improved apparatus for extracting or reducing metals or making metallic alloys by electrolysis." H. Bumb. Dated March 23rd. (*Complete.*)

6,300. "Improvements in apparatus for electro-plating." H. Beckmann. Dated March 23rd. (*Complete.*)

6,303. "Electric safety alarm appliance to clothes hooks to prevent theft of garments and the like." R. Schmid and R. Basch. Dated March 23rd.

6,321. "Improvements in or connected with surface contact studs for electric traction." W. Kingsland. Dated March 23rd.

6,322. "Improvements in or relating to electric cables." A. Whalley. Dated March 23rd.

6,335. "An improved device for producing electric current at sea by the action of the waves." M. Gehre. Dated March 23rd.

6,343. "Improvements in volting machines." F. W. Purcell. Dated March 23rd. (*Complete.*)

6,344. "Improvements in or connected with apparatus specially applicable for lighting and heating by electricity." O. O. Domon. Dated March 23rd.

6,347. "Improvements in electric brakes for railway and tramway vehicles." W. L. Wise. (The Actiengesellschaft Elektricitatswerke (Vorm O. L. Kummer & Co.) Germany). Dated March 23rd. (*Complete.*)

6,349. "Improvements in telegraph and such like posts." Siemens Bros. & Co., Limited, and G. W. Perry. Dated March 23rd. (*Complete.*)

6,353. "Improvements in apparatus for the generation and electrolytic application of electric currents." F. E. Elmore. (Partly by J. O. S. Elmore, India.) Dated March 23rd.

6,395. "Improvements in appliances for transmitting the current from a charged wire to an electrically propelled vehicle." W. R. Wynne. Dated March 24th.

6,396. "Improvements in and relating to electrical coin shoots for automatic coin-freed apparatus." M. Heyder. Dated March 24th. (*Complete.*)

6,420. "Improvements relating to electrical resistance boxes and like apparatus and switches therefor." C. T. Gambrell and T. E. Gambrell. Dated March 24th. (*Complete.*)

6,439. "Improvements in combined telephonic jacks and call indicators." Siemens Bros., & Co, Limited. (Siemens & Halske, Actiengesellschaft, Germany.) Dated March 24th. (*Complete.*)

6,441. "Improvements in electric cables." T. Cables. Dated March 24th.

6,443. "An improved pocket galvanometer." C. Beez. Dated March 24th. (*Complete.*)

6,473. "Improvements in electrical apparatus for igniting gas burners from a distance." C. Bolle. (C. Fitzlaff, Germany.) Dated March 25th.

6,478. "Improvements in electric arc lamps." R. F. Hall. Dated March 25th. (*Complete.*)

6,484. "The Fairy Mountain, electrical switchback continuous railway with enchanted reptiles, snakes, dragons, and other animals." C. Ercole and A. Charpoulart. Dated March 25th.

6,487. "Improvements in electric switches." The British Thomson-Houston Company, Ltd., and F. Samuelson. Dated March 25th.

6,510. "Differential hot-wire voltmeter." A. M. Clark. (The firm of Hartmann & Braun, Germany.) Dated March 25th. (*Complete.*)

ELECTRICAL PATENTS OF 1885 EXPIRING IN APRIL, 1899.

We are informed by W. P. Thompson & Co. that about 100 applications for electrical patents were filed in April, 1885. Of these some were never completed, and of those that were only four have been maintained to run their full term, viz., 14 years, and being of considerable interest we give short abstracts of them below:—

4,499. F. E. Elmore. Dated April 11th, 1885. Relates to the process of making tubes or cylinders described in Specification No. 1,737, A.D. 1885. The cylindrical core, which expands on heating or cooling at a different rate from the metal of which it is proposed to make the tube, is coated with bronze powder to receive the non-adhesive deposit, and is made to rotate in the bath from which the metal is deposited by electrolysis upon it, the contact being made by a brush wiping against the roller. The carriage traverses to and fro and carries burnishers made of some hard non-conducting substance which press by the weight of the holder. The tube is subsequently detached by heating or cooling, in which latter case the bath must be maintained at a high temperature.

4,671. D. G. FitzGerald. Dated April 11th, 1885. Relates to the production of plates, more especially applicable for secondary batteries formed of oxide of lead. Litharge is mixed to a paste with ammonium phosphate, sulphate, &c. (an acid being used which forms an insoluble lead salt), together with ammonium chloride, which may, however, in certain cases be omitted. The plastic mass is then pressed and moulded in a suitable frame. Those plates which are intended to be used as cathodes in charging are made about half the thickness of those for the anodes, or a sheet of lead coated with the plastic mass of lead oxide and fixed to a connecting wire, may be used as a cathode. The electrolyte for charging is preferably magnesium sulphate, but ammonium or sodium sulphate may also be employed; the cathodes when converted into porous lead are employed as positive elements in a battery trough containing sulphuric acid. The anodes made as above described should be carefully supported in the electrolytic trough to avoid warping. Before conversion in the trough these plates are superficially peroxidised by treatment with sodium, or preferably magnesium hypochlorite.

5,201. C. D. Abel. (C. Zipernowski, M. Dari and O. T. Blathy.) Dated April 27th, 1885. Relates to induction coils. The iron is distributed so as form closed magnetic circuits near the copper conductors. In one form the primary and secondary are whipped round a ring formed of insulated iron wires. The iron wire may be replaced by a series of iron plates.

5,208. P. B. Delany.[1] Dated April 28th, 1885. Relates to facsimile or autographic telegraphy, and consists in the use of synchronously actuated circuit-completers, by which several styles or fingers can be used at each end, in combination with only one line wire. Some of the contacts of the synchronously-actuated circuit-completers are used purely for synchronising purposes. One method of working the apparatus is by having the main battery continually in the line; another method is by connecting the line through relays, and only throwing the main battery into the line at the instant of transmission. The invention is not dependent upon any particular form of machine.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free,* 9*d.* (*in stamps*).

1897.

488. "Improvements in dynamo-electric machines and electromotors." A. W. Marshall. Dated January 7th, 1897. *Dynamos and Motors, Field Magnets, Frames.*—The bed-plate and standards, which support the armature shaft, are made in one casting, as is also the field magnet. The yoke of the latter is turned concentrically to the armature shaft, and rests on a concave face formed on the base plate, to which it is secured by a screw. The construction is somewhat modified for a single-coil machine and for an under-type machine. Each of the standards is bored out, and provided with a vertical slot to receive a cylindrical bush through which passes the armature shaft. The brushes are secured in the standards by means of set screws. 3 claims.

1,487. "Improvements in telephone and other electric switches." E. E. Ries. Dated January 19th, 1897. (Date applied for under Patents, &c., Act, 1883, Sec. 103, June 26th, 1896, being date of application in the United States.) Switches for telephone and other purposes consist of a vulcanite, &c., thimble having a cup secured in the bottom and connected to the call apparatus, two contact rings near the upper end connected to the circuits of the receiving and transmitting instruments or other circuits. The thimble is closed by a screw plug having an iron rod passing nearly to the bottom of the thimble and connected to the line. The thimble contains a small quantity of mercury or small shot, having some powdered graphite sprinkled on or amongst the contact material. 12 claims.

1,849. "Improvements in electric railways on the conduit system." N. H. Balfour and E. W. Smith. Dated January 23rd, 1897. Relates to electric railways and tramways with road contacts or sectional conductors, which are connected to the main conductor by a trolley running in an enclosed conduit, and kept in touch with the vehicle by electro-magnets. The cover of the conduit is built up of transverse iron bars, separated by non-magnetic material, and held together by bolts. These bars complete the magnetic circuit between the trolley and the vehicle. The road contacts or sectional conductors inside and outside the conduit may be attached to the cover, or otherwise placed. 3 claims.

2,272. "Improvements in or connected with electric batteries." J. L. Dobell. Dated January 28th, 1897. An iron cell is arranged so that it may be heated by a furnace or by gas burners, &c. A truncated cone of iron gauze, &c., is mounted within it, and iron funnel tubes dip nearly to the bottom of the cell. A porous pot, preferably of magnesite, is placed centrally as shown, and a tube which may form one terminal of the cell, is mounted within it for the purpose of supplying air or oxygen to the molten litharge which it contains. Molten lead is employed in the outer cell, and charcoal, or like carbonaceous fuel is fed into it through the tubes while the cell is at work. The carbon deoxidises the lead, while the supply of air through the pipe oxidises the lead reduced in the porous cell. The cell may itself serve as the negative electrode. Other metallic oxides may replace the litharge, and the negative electrode is not necessarily of iron. 3 claims.

2,701. "Improvements in electric propulsion." L. H. Nash. Dated February 2nd, 1897. Relates to the electric propulsion of street cars, road carriages, boats, &c. A prime mover, such as a gas or petroleum engine, drives a dynamo mounted on the vehicle, and the latter supplies current to electric motors connected with the wheels of the vehicle. The field magnet of the dynamo is wound with a shunt coil, and, in the opposite direction with a series coil; the field magnet of the motor is wound with a series coil only. When the vehicle encounters great resistance, as in going up a hill, the dynamo automatically supplies the motor with an increased current at a lower voltage, and the vehicle slows down to the point at which the prime mover can drive it up the grade. A variable resistance is introduced into the shunt circuit of the dynamo for controlling the speed of the motor. 6 claims.

2,935. "Improvements in switches for electric currents." W. R. Rawlings and J. J. Rawlings. Dated February 3rd, 1897. Relates to improvements in switches in combination with lampholders. An insulated base secured to the casing of the holder, and carrying the terminals for the line wires and the contacts of the switch is provided. The terminal is connected to one contact, and the other terminal to one of the plungers of the lampholder. The contact connects the other plunger of the lampholder. The circuit is completed when a sliding block carrying spring contact plungers is moved by a suitable spindle. The base is so constructed as to give a quick break when the spindle is drawn back. The plungers and base may be arranged as described in Specifications Nos. 22,402, 23,071, 24,766 and 28,704, A.D. 1896, and may allow of the use of a selection of filaments. Instead of a sliding block carrying the contacts, a rocking lever may be employed. 2 claims.

3,113. "Improvements in electrical accumulators." R. R von Perks and J. Benger. Dated February 5th, 1897. The plates are formed with knife edges at their extremities which bear against similar edges on glass separators. The connections to the leads are made from opposite diagonal corners as shown. The plates have also ribbed projections provided with longitudinal grooves. In the negative plates the projections are farther apart than in the positive and intermediate smaller ribs are provided. 4 claims.